AR201-13434

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cc: Barbara Leczynski/DC/USEPA/US@EPA

Subject: Olefins Panel Resin Oils Test Plan

Attached is the Olefins Panel's test plan and robust summaries for the Resin Oils and Cyclodiene Concentrates category.

(See attached file: Resin Oils Cover Letter PDF.pdf)(See attached file: Resin Oils Test Plan PDF.pdf)(See attached file: Resin Oil RS DCPD PDF.pdf)(See attached file: Resin Oil RS MCPD PDF.pdf)(See attached file: Resin Oil RSC9resin PDF.pdf)(See attached file: Resin Oil RSResin-formerfeed PDF.pdf)

Resin Oils Cover Letter PDF.pdf Resin Oils Test Plan PDF.pdf Resin Oil RS DCPD PDF.pdf Resin Oil RS MCPD PDF.pdf

Resin Oil RSC9resin PDF.pdf Resin Oil RSResin-formerfeed PDF.pdf

December 18, 2001

Christine Todd Whitman, Administrator
U.S. Environmental Protection Agency
P. O. Box 1473
Merrifield, VA 22116

RE: Olefins Panel Test Plan for the Resin Oils and Cyclodiene Dimer Concentrates Category, HPV Registration No. [redacted]

Dear Ms. Whitman:

The Olefins Panel of the American Chemistry Council submits its test plan and robust summaries for the Resin Oils and Cyclodiene Dimer Concentrates Category under the High Production Volume (HPV) Challenge Program. The CAS numbers in this category are listed in the attached table. This category test plan addresses nine related petrochemical streams. These streams are complex mixtures containing primarily C8 to C12 cycloalkenes and aromatic hydrocarbons.

In preparing this test plan, the Panel has given careful consideration to the principles contained in the letter EPA sent to all HPV Challenge Program participants on October 14, 1999. As requested by EPA in that letter, the Panel has sought to maximize the use of scientifically appropriate categories of related chemicals and of structure activity relationships. The Panel has coordinated with other industry groups covering related chemicals. Additionally, and also as requested in EPA's letter, in analyzing the adequacy of existing data, the Panel has conducted a thoughtful, qualitative analysis rather than a rote checklist approach. The Panel has taken the same thoughtful approach when developing this test plan and believes it conforms to those principles.

If you have any questions, please contact Elizabeth Moran, Manager of the Olefins Panel at (301) 924-2006 or Elizabeth_Moran@americanchemistry.com.

Sincerely yours,

Courtney M. Price
Vice President, CHEMSTAR

cc: C. Auer, EPA
B. Leczynski, EPA
S. Russell, ACC
J. Keith, ACC

CAS Numbers for
Resin Oils and Cyclodiene Dimer Concentrates Category

CAS Number	CAS Number Description
26472-00-4	4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydrodimethyl-
68477-40-7	Distillates, petroleum, cracked stripped steam-cracked petroleum distillates, C10-12 fraction
68477-54-3	Distillates, petroleum, steam-cracked, C8-12 fraction
68477-53-2	Distillates, petroleum, steam-cracked, C5-12 fraction
68478-08-0	Naphtha, petroleum, light steam-cracked, C5-fraction, oligomer conc.
68478-10-4	Naphtha, petroleum, light steam-cracked, debenzenized, C8-16-cycloalkadiene conc.
68516-20-1	Naphtha, petroleum, steam-cracked middle arom.
68527-24-2	Naphtha, petroleum, light steam-cracked arom., C5-12 cycloalkadienefraction, polymers
68527-26-4	Naphtha, petroleum, light steam-cracked, debenzenized
68603-02-1	Distillates, petroleum, thermal cracked naphtha and gas oil, dimerized

Note: The definitions, found in the TSCA Chemical Substance Inventory, for the CAS numbers included in this group are vague with respect to composition. Therefore, it is not uncommon to find that the same CAS number is correctly used to describe different streams (compositions) or that two or more different CAS numbers are used to describe the same stream (composition)

AR201-13434A

HIGH PRODUCTION VOLUME (HPV)

CHEMICAL CHALLENGE PROGRAM

TEST PLAN

For The

Resin Oils and Cyclodiene Dimer Concentrates Category

Prepared by:

American Chemistry Council
Olefins Panel
HPV Implementation Task Group

December 18, 2001

PLAIN ENGLISH SUMMARY

This category test plan addresses nine related petrochemical process streams derived from distillation, and in some cases thermal processing, and further purification of the pyrolysis gasoline stream from the ethylene process unit. The category has been designated "Resin Oils and Cyclodiene Dimer Concentrates." The defining substance in the category is the dicyclic alkene, dicyclopentadiene (DPCD). Based on processing and compositional differences, the streams are grouped into three subcategories: 1) High DCPD Resin Oils, 2) Low DCPD Resin Oils, and 3) Cyclodiene Dimer Concentrates. The streams that form this category are complex mixtures containing primarily C8 to C12 cycloalkenes and aromatic hydrocarbons.

Human Health Effects

DCPD, the defining substance of this category had been addressed under the OECD (Organization for Economic Cooperation and Development) SIDS (Screening Information Data Sets) program, and therefore has an established screening data set and hazard profile for human health and environmental effects and fate. DCPD process streams are expected to possess toxicity similar to DCPD and a limited but appropriate amount of testing is proposed to demonstrate this premise.

The strategy of this screening level test program for characterizing human health hazards of members of this category is to evaluate data for the key component (existing data for DCPD) and component families [existing and new data that will be generated by the Olefins Panel and by other groups as part of the EPA HPV (High Production Volume) Challenge, OECD SIDS, and ICCA (International Council of Chemical Associations) HPV programs]. In addition, three representative streams are proposed to be tested in this program. These data are expected to satisfy HPV program requirements for the substances included in this category.

The following health effects tests are proposed to be conducted by the American Chemistry Council Olefins Panel within this test plan:

- Bacterial genetic toxicity test, mouse genetic toxicity test, and rat repeated dose test for toxicity screening to the reproductive, developmental and nervous systems for the Resin Oils representative stream, Low DCPD Resin Oil.

- Bacterial genetic toxicity test, mouse genetic toxicity test, and rat repeated dose test for toxicity screening to the reproductive, developmental and nervous systems for the Cyclodiene Dimer Concentrates stream, DCPD/Codimer Concentrate.

- Bacterial genetic toxicity test, mouse genetic toxicity test, and rat repeated dose test for toxicity screening to the reproductive, developmental and nervous systems for the Cyclodiene Dimer Concentrates stream, Methylcylopentadiene Dimer (MCPD Dimer).

Environmental Effects and Fate

The following environmental effect and fate tests, technical discussions, and computer modeling are proposed to be conducted or prepared by the Panel within this test plan:

- Resin Oils representative stream, Low DCPD Resin Oil - Fish acute toxicity test, invertebrate immobilization acute toxicity test, alga growth inhibition test, and manometric respirometry biodegradation test. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. Indirect photodegradation rates will be calculated for selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model are proposed for selected chemicals in this stream.

- Cyclodiene Dimer Concentrates representative stream, DCPD/Codimer Concentrate - Fish acute toxicity test, invertebrate immobilization acute toxicity test, alga growth inhibition test, and manometric respirometry biodegradation test. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. Indirect photodegradation rates will be calculated for selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model are proposed for selected chemicals in this stream.

- Cyclodiene Dimer Concentrates representative stream, MCPD Dimer - An alga growth inhibition test and a manometric respirometry biodegradation test. Additional aquatic toxicity testing will depend on the outcome of the alga study and may include a fish acute toxicity test and an invertebrate immobilization acute toxicity test. Technical discussions will be prepared on the potential of MCPD dimer to undergo hydrolysis and photolysis. The indirect photodegradation rate for MCPD dimer will be calculated. Fugacity calculations (chemical distribution) using a computer model are proposed for the MCPD Dimer.

Physicochemical Properties

The following physicochemical data are proposed to be developed by the Panel within this test plan for the Low DCPD Resin Oil and DCPD/Codimer Concentrate streams: Measured physicochemical data will be developed for the boiling point range, vapor pressure, and octanol-water partition coefficient (Kow) range endpoints. Calculated data are also proposed to be developed for these three endpoints, as well as melting point range and water solubility range. Measured and calculated physicochemical data for the MCPD dimer are proposed to be developed and will include: boiling point, vapor pressure, Kow, and water solubility. A calculated melting point is also proposed.

EXECUTIVE SUMMARY

The Olefins Panel (Panel) of the American Chemistry Council and the Panel's member companies hereby submit for review and public comment the test plan for the Resin Oils and Cyclodiene Dimer Concentrates Category under the Environmental Protection Agency's (EPA) High Production Volume (HPV) Chemical Challenge Program. It is the intent of the Panel and its member companies to make maximum possible use of existing data, in conjunction with new information and scientific judgment/analysis, to characterize the Screening Information Data Set (SIDS) human health, environmental fate and effects, and physicochemical endpoints for this category in satisfaction of HPV program requirements.

The category test plan addresses nine related petrochemical process streams derived from distillation, and in some cases thermal processing, and further purification of the pyrolysis gasoline stream from the ethylene process unit. The streams that form this category are complex mixtures containing primarily C8 to C12 cycloalkenes and aromatic hydrocarbons. The defining substance in the category is the dicyclic alkene, dicyclopentadiene (DPCD). Ten CAS numbers are used to describe the streams in this category. The category has been designated "Resin Oils and Cyclodiene Dimer Concentrates" and based on processing and compositional differences, the streams are grouped into three subcategories: 1) High DCPD Resin Oils, 2) Low DCPD Resin Oils, and 3) Cyclodiene Dimer Concentrates. All but two of the streams contain amounts of DCPD (> 1%). One of the streams, Low DCPD Resin Oils, contains insignificant DCPD content in the resin oil matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons. The other stream containing de minimis DCPD content is Methylcyclopentadiene Dimer (MCPD Dimer), a Cyclodiene Dimer Concentrates stream processed to maximize MCPD Dimer content.

DCPD, the defining substance of this category, is an OECD SIDS chemical with an established screening data set and hazard profile for human health and environmental effects and fate. DCPD process streams are expected to have toxicity properties similar to DCPD and will be tested to demonstrate this premise.

The streams that are proposed to be tested by the Panel are described below:

- Low DCPD Resin Oil: This is a low DCPD stream (typically <1%) comprised of the resin oil matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons and is representative of the Low DCPD Resins Oils.

- DCPD/Codimer Concentrate: This is a DCPD stream typically containing approximately 40% DCPD in addition to the non-resin oil matrix of comparable molecular weight codimers and is representative of the Cyclodiene Dimer Concentrates group of streams.

- MCPD Dimer: This is a MCPD Dimer stream typically containing 90% MCPD dimer. The majority of the remaining chemical constituents in this stream can include codimers and trimers of DCPD and MCPD.

Based upon existing information plus the newly to-be-developed data from this and other testing programs, scientifically-based characterizations of the streams in this category will be achieved.

Human Health Effects

The following health effects tests are proposed by the Panel within this test plan:

- Low DCPD Resin Oil: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

- DCPD/Codimer Concentrate: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

- MCPD Dimer: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/ neurotoxicity screen (OECD Guideline 422).

Based upon examination of stream compositions and existing toxicity data for C8 to C12 cycloalkenes and aromatic hydrocarbons, there is minimal likelihood for the appearance of unexpected or remarkable biological findings in testing of streams within this chemical class. Chemicals in this class have been evaluated as isolated components or components of mixed streams for CNS (central nervous system) depressant and anesthetic potencies, irritation properties, and aspiration hazards. Reviews of this literature appear in *Patty's Industrial Hygiene & Toxicology, Chapters 20 and 21, Volume IIB, 4th Edition (1994).* Less information exists regarding the repeated exposure cumulative toxicity properties of these chemicals. DCPD, however, has been tested for repeated exposure toxicity and demonstrated to be moderately toxic with kidney toxicity consistently observed. The kidney toxicity, however, is hyaline droplet nephropathy, a condition commonly observed in male rats that receive hydrocarbon and other substances. Hyaline droplet nephropathy is not considered relevant to humans. Non-specific systemic effects (such as depression of body weight) and changes to the liver and other organs have also been observed in laboratory animals receiving high doses of DCPD.

The strategy of this screening level test plan for characterizing the human health hazards of the members of this category is to evaluate data for three representative streams and for the major component/component families (existing and new data that will be generated by the Olefins Panel and by other groups as part of the EPA HPV, OECD SIDS, and ICCA HPV programs). These data are expected to be sufficient to satisfy HPV requirements regarding the human health hazards of the substances included in this category.

Environmental Effects and Fate

The following environmental effect and fate tests, technical discussions, and computer modeling are proposed to be conducted or prepared by the Panel within this test plan:

- Low DCPD Resin Oil: A fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), and a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the Low DCPD Resin Oil stream. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include chemicals in this stream.

- DCPD/Codimer Concentrate: A fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), and a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the DCPD Concentrate stream. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include chemicals in this stream.

- MCPD Dimer: An alga growth inhibition test (OECD Guideline 201) and a manometric respirometry biodegradation test (OECD Guideline 301F). Additional aquatic toxicity testing will depend on the outcome of the alga study and may include a fish acute toxicity test (OECD Guideline 203) and an invertebrate immobilization acute toxicity test (OECD Guideline 202), an invertebrate reproduction test (OECD Guideline 211). Technical discussions will be prepared on the potential of MCPD dimer to undergo hydrolysis and photolysis. The indirect photodegradation rate for MCPD dimer will be calculated. Fugacity calculations (chemical distribution) using a computer model will be performed for the MCPD Dimer.

Read across aquatic toxicity data as well as limited data for a product in this category suggest that resin oil and cyclodiene dimer concentrate products have the potential to produce a moderate level of toxicity in freshwater algae and acute toxicity in freshwater fish and invertebrates. To confirm this assessment, the toxicity of three products from this category to three freshwater organisms will be determined by laboratory testing.

Limited biodegradation data for chemical components and complex products identified as read across data to the Resin Oils and Cyclodiene Dimer Concentrates Category suggest that products in this category have the potential to biodegrade to a significant extent. To confirm this assessment, the biodegradability of three products from this category will be determined. The chemical components in these products are relatively volatile, and if released they would be expected to partition to the air to a significant extent. In the air, they are subject to rapid physical degradation through hydroxyl radical attack. Therefore, as a result of both biological and physical degradation processes, these products are not expected to persist in the environment.

Information has not been developed on the potential of products in this category to photodegrade, hydrolyze, and partition within the environment. Therefore, information or data will be developed for these endpoints.

Physicochemical Properties

The following physicochemical data are proposed to be developed by the Panel within this test plan for the Low DCPD Resin Oil and DCPD/Codimer Concentrate streams: Measured physicochemical data will be developed for the boiling point range, vapor pressure, and octanol-water partition coefficient (Kow) range endpoints. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components. Measured and calculated physicochemical data for the MCPD dimer will be developed and will include: boiling point, vapor pressure, Kow, and water solubility. A calculated melting point will also be developed. Although there are data for selected physicochemical endpoints, a comprehensive and consensus database does not exist for the Resin Oils and Cyclodiene Dimer Concentrates Category. Therefore, data will be developed and/or identified to characterize the physicochemical endpoints in the HPV Chemical Program.

LIST OF MEMBER COMPANIES
THE OLEFINS PANEL

The Olefins Panel includes the following member companies:

ATOFINA Petrochemicals, Inc.*
BP Chemical Company *
Chevron Phillips Chemical Company LP
The Dow Chemical Company
E. I. du Pont de Nemours and Company*
Eastman Chemical Company*
Equistar Chemicals, LP
ExxonMobil Chemical Company
Formosa Plastics Corporation, U.S.A.*
The Goodyear Tire & Rubber Company
Huntsman Corporation*
Koch Industries*
NOVA Chemicals Inc.
Noveon, Inc.
Sasol North America, Inc.*
Shell Chemical Company
Sunoco, Inc.*
Texas Petrochemicals Corporation*
Westlake Chemical Corporation*
Williams Olefins, LLC*

* These companies are part of the Olefins Panel but do not produce streams in the Resin Oils and Cyclodiene Dimer Concentrates Category.

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TEST PLAN FOR THE RESIN OILS AND CYLODIENE DIMER CONCENTRATES CATEGORY

I. INTRODUCTION

The Olefins Panel (Panel) of the American Chemistry Council and the Panel's member companies have committed to develop screening level human health effects, environmental effects and fate, and physicochemical data for the Resin Oils and Cyclodiene Dimer Concentrates Category under the Environmental Protection Agency's (EPA's) High Production Volume (HPV) Challenge Program (Program).

In preparing this test plan, the Panel has given careful consideration to the principles contained in the letter EPA sent to all HPV Challenge Program participants on October 14, 1999. As directed by EPA in that letter, the Panel has sought to maximize the use of scientifically appropriate categories of related chemicals and structure activity relationships. Additionally, and also as directed in EPA's letter, in analyzing the adequacy of existing data, the Panel has conducted a thoughtful, qualitative analysis rather than use a rote checklist approach. The Panel has taken the same thoughtful approach when developing its test plan. The Panel believes its test plan conforms to the principles articulated in EPA's letter.

This plan identifies ten CAS numbers (Table 1) used to describe nine process streams in the category, identifies existing data of adequate quality for substances included in the category, and outlines testing needed to develop screening level data for this category under the Program. This document also provides the testing rationale for the Resin Oils and Cyclodiene Dimer Concentrates Category. The objective of this effort is to identify and develop sufficient test data and/or other information to characterize the human health and environmental effects and fate for the category in accordance with the EPA HPV Program. Physicochemical data that are requested in this program will be calculated as described in EPA guidance documents. In addition, measured data will be provided for selected products in this category when available.

II. DESCRIPTION OF THE RESIN OILS AND CYLCODIENE DIMER CONCENTRATES CATEGORY

A. The Category

Ten CAS numbers are used to describe streams in this category (Table 1). The ethylene industry produces two types of Resin Oil streams; one that is relatively low in DCPD, and a second that contains a higher level of the dimer. These Resin Oils, and six other streams that are concentrates of DCPD, Methylcyclopentadiene Dimer (MCPD Dimer) and codimers of these two cyclodienes with other hydrocarbons of similar molecular weight, are grouped for HPV testing purposes.

The CAS Numbers in the Resin Oils and Cyclodiene Dimer Concentrates Category are associated with nine streams that are commercial products or isolated intermediates:

Stream (Industry Description)
High DCPD Resin Oils
(1) High DCPD Resin Oil
Low DCPD Resin Oils
(2) Low DCPD Resin Oil
(3) Resin Former
Cyclodiene Dimer Concentrates
(4) DCPD Concentrate
(5) DCPD, High Purity
(6) DCPD Purge Stream
(7) MCPD Dimer
(8) DCPD Stream
(9) DCPD/Codimer Concentrate

B. Process Stream Descriptions

(1)-(3) Resin Oils, High DCPD, Low DCPD and Resin Former: Resin oils are produced as a distillate from pyrolysis gasoline and usually have a carbon number distribution that is predominantly C8 to C10. The composition of the resin oils varies and this is most obvious with respect to DCPD content, which is typically about 55% for the "high DCPD" streams and less than 1% for the "low" DCPD streams. This variation in composition results from the ethylene process design and feedstock.

(1) High DCPD Resin Oils: This stream typically contains about 55% DCPD, and significant levels of vinyl aromatics and codimers of cyclopentadiene with other monomers such as isoprene, pentadiene and methylcyclopentadiene. The highest boiling component in the stream is normally naphthalene and it is present usually at less than about 0.5%.

(2) Low DCPD Resin Oils: This stream consist of components that are similar to those found in the high DCPD stream (vinyl aromatics) with the exception that DCPD and the codimers are present only at very low level (typically <1% DCPD).

(3) Resin Former: A participant in the Panel's HPV program who processes resin oil streams from various ethylene units produces this stream. Resin Former is most similar to the Low DCPD stream, with typical DCPD content reported as about 6.7%.

(4) Dicyclopentadiene (DCPD) Concentrate: DCPD is produced from the Pyrolysis C5 Fraction by a combination of distillation and heat soak (dimerization) unit operations. DCPD content of the stream is typically 75% with the balance predominantly codimers of cyclopentadiene with other C5 monomers. The stream typically contains relatively low levels of low boiling hydrocarbons (C5-C8).

(5) Dicyclopentadiene (DCPD), High purity: Dicyclopentadiene can be purified to about 95% by a combination of thermal and distillation unit operations. The main impurities remaining in the stream are codimers and trimers of cyclopentadiene.

(6) Dicyclopentadiene (DCPD) Purge Stream: The DCPD Purge Stream results from the distillation process that separates the DCPD/Codimer Concentrate stream and the MCPD Dimer stream from the C8+ fraction of a thermally-processed pyrolysis gasoline. The DCPD Purge Steam typically contains 18% DCPD, with the balance largely codimers and C8 Aliphatics and aromatics.

(7) Methylcyclopentadiene Dimer (MCPD Dimer): MCPD Dimer is isolated by distillation from the C8+ fraction of a thermally processed pyrolysis gasoline. Typical purity is 90% as the dimer and the main impurities in the stream are codimers and trimers of DCPD and MCPD.

(8) DCPD Stream: This stream is produced as the bottoms from a distillation tower that is charged with a DCPD-containing stream together with the heavy ends and raffinate from an isoprene extractive distillation unit. This stream is reported to contain about 50% DCPD, with the balance being largely C5s, both saturates and unsaturates.

(9) DCPD/Codimer Concentrate: This stream is isolated by distillation from the C8+ fraction of a thermally processed pyrolysis gasoline. This stream typically contains about 40% DCPD with the balance primarily codimers of cyclopentadiene with piperylene, butadiene and methylcyclopentadiene.

III. TEST PLAN RATIONALE

A. Human Health Effects - Overview

The Resin Oils and Cyclodiene Dimer Concentrates Category consists of mixed hydrocarbon streams with a carbon number distribution that is predominantly C8 to C12. The predominant components are cycloalkenes and aromatic hydrocarbons.

DCPD (CAS No. 77-73-6) is a mid-range (C10) dicyclic alkene found at varying levels in many of the category streams. DCPD is an OECD (Organization for Economic Cooperation and Development) SIDS (Screening Information Data Sets) chemical with an established screening data set and hazard profile for human health and environmental effects (OECD, 1998). The toxicology of DCPD has been reviewed by Cavender (1994a) and ECETOC (1991) and a summary of this information follows. Details of key studies pertinent to the OECD SIDS health effects endpoints are provided in the robust summaries that accompany this test plan. The available health effects information indicates that DCPD is moderately toxic by relevant routes of exposure. Acute lethal oral doses in animal species are variable ranging from 0.19 g/kg in the mouse to approximately 1.2 g/kg in cattle. Lethal vapor concentrations are also variable, ranging, for 4-hour exposures, from 145 ppm for the mouse, to approximately 770 ppm for the guinea pig and rabbit. With substantially saturated vapor concentrations (2500 ppm), death ensued in rats within 60 minutes of exposure. Similar to other hydrocarbons, the predominant acute systemic effect is on the central nervous system; DCPD produces initial stimulation followed by prolonged depression. DCPD has a

disagreeable odor similar to camphor and has reportedly resulted in headaches in workers following prolonged exposure to low vapor concentrations. DCPD is also irritating when directly applied to the skin and eyes and may be an aspiration hazard.

Several studies have evaluated DCPD for repeated exposure effects. The most consistent effect at non-lethal doses was to the kidneys of male rats but some studies also found effects to the lung, liver, gastrointestinal tract, and adrenal gland. In feeding studies, DCPD given for up to 90 days to mice and rats did not result in treatment-related effects at nominal dietary concentrations up to 273 ppm or 750 ppm, respectively. Dogs in a similar study exhibited some evidence of gastro-intestinal disturbance at the highest dietary concentration (1,000 ppm nominal). In the most recent study conducted by gavage and according to OECD Guideline 422 , daily exposure to 4, 20, or 100 mg/kg DCPD produced a variety of effects to male and female rats (JETOC, 1998). Two females (of ten) in that received 100 mg/kg died during treatment and (all) males and surviving females exhibited slight suppression of body weight gain and decreased feed consumption. Male rats of the high dose group demonstrated increase in liver enzymes, increased liver and kidney weight, and microscopic findings of single cell necrosis in the liver and hyaline droplets and renal tubular changes in the kidney. The kidney microscopic changes were also observed in the male rats that received 4 and 20 mg/kg DCPD. Both males and females in the 100 mg/kg group and males in the 20 mg/kg group also exhibited increase in fatty droplets in the adrenal glands. The no observed effect level doses for repeat dose toxicity for this study were considered to be 20 mg/kg/day for females and less than 4 mg/kg/day for males.

Repeated inhalation exposure of laboratory animals to DCPD vapor also produced kidney lesions in male rats of several studies. The kidney lesions described in these studies give the appearance of the male rat specific disease hyaline droplet nephropathy, a condition not considered relevant to humans. Lung lesions described as chronic pneumonia and bronchiectasis was reported in rats exposed to 35 and 74 ppm (Kinkead *et al*., 1971); however in a second study (Bevan *et al*., 1992), no lung lesions were observed in rats repeatedly exposed to 50 ppm DCPD.

DCPD is not selectively toxic to rodent reproduction or the developing embryo/fetus. In a reproductive/developmental toxicity screening study conducted by oral gavage (JETOC, 1998), no effects were noted on reproductive parameters at up to 100 mg/kg. This dose, however, was lethal to 2 (of 10) female rats and 2 rats of this group (presumably the same animals) lost 100% of their litters during lactation (days 1-4). A low viability index and tendency to lower birth weight and body weight gain were observed in neonates in the highest dose group. The no observed effect level doses for this study were 100 mg/kg/day for parental males and 20 mg/kg/day for parental females and offspring. The NTP evaluated the potential reproductive toxicity of orally (gavage) administered DCPD (10, 30, or 100 mg/kg) in rats using a continuous breeding protocol (Jamieson *et al*., 1995). DCPD at 100 mg/kg produced lower pup weights, increased pup mortality, fewer pups born alive, and increased cumulative days to litter. In the 30 mg/kg group, only a slight (4%) reduction in the average female pup weight was observed. There were no reproductive effects observed in the 10 mg/kg group. Decreased (F2) pup weight in the 100 mg/kg group was noted in the

second generation litters. Epididymal sperm density, percent motility, percent abnormal sperm, spermatids per milligram of testis, and total spermatids per testis were not affected by the administration of DCPD at dose levels employed in this study. At the doses that yielded reproductive effects, parental animals exhibited effects on liver and kidney; hence the DCPD reproductive effects that were observed in this study were not considered by NTP to be selective. A 3-generation reproduction study of DCPD administered to rats in the diet at 80 and 750 ppm resulted in no deleterious effects on reproductive processes or general condition of the rats and no evidence of dose-related teratologic effect over three successive generations with two matings per generation (Hart, 1980).

Developmental toxicity range-finding studies were conducted by NTP in New Zealand White rabbits and Sprague-Dawley rats (Gulati *et al*., 1993a,b). DCPD administered by gavage at 25, 100, 200, 300, or 400 mg/kg to rabbits caused maternal toxicity at 200 mg/kg and higher doses. Gross deformities were evident at 400 mg/kg but no other developmental endpoints were significantly affected. Rats were administered DCPD at 50, 200, 300, 400, and 500 mg/kg by gavage. Body weights were significantly decreased at two time points and for body weight gain throughout the treatment for rats in the 50 and 200 mg/kg groups. Clear maternal toxicity, including maternal death, was observed at 200 mg/kg and higher doses (3/7 in the 200 mg/kg group, 8/9 in the 300 mg/kg group, and all in the 400 and 500 mg/kg groups were found dead by gestation day 9). Developmental toxicity in the form of decreased fetal weight was observed in the 200 mg/kg group. In a rat teratology study there were no effects on pregnant dams from dietary administration of 80, 250, or 750 ppm DCPD and no compound-induced terata, variation in sex ratio, embryo toxicity or inhibition of fetal growth and development (Hart, 1980).

DCPD is not toxic to genetic mechanisms either in bacterial or mammalian systems. Tests for mutations and chromosomal effects have been negative for DCPD. DCPD has not been evaluated for carcinogenic effects.

The biological activity of DCPD is expected to be similar to that of other physicochemically similar C8 to C12 cycloalkenes. There is less information available, however, for other mono- and dicyclic alkenes and their substituted derivatives as these substances are of lesser commercial interest. The toxicology properties of cycloalkenes is reviewed by Cavender (1994a). The available information for C8 to C12 cycloalkenes indicate these hydrocarbons show similar acute toxicity profiles as DCPD in terms of lethal dosages and clinical signs dominated by CNS effects. The liquid cycloalkenes in this range are also considered aspiration hazards. These hydrocarbons exhibit irritation effects with some producing severe and corrosive effects to the skin (e.g. cyclooctadiene). Some members are also skin sensitizers. There is very limited reliable information available on the toxic effects of C8 to C12 cycloalkenes following repeated exposure. A few studies have been conducted on limonene (a C10 cycloalkene that occurs in the oil of many plants). Decreases in body weight and non-specific systemic effects were noted in mice and dogs that received oral doses of limonene for up to 1 to 6 months. In male rats, limonene resulted in formation of hyaline droplets in the kidneys, a similar finding with DCPD. A short term (9 day) repeated inhalation exposure study has been conducted in the rat and mouse for

methylcyclopentadiene dimer (MCPD dimer), a C12 dicyclic alkene (Dodd and Longo, 1982). As with DCPD, MCPD dimer was found to target the rat kidney and there was some indication of effects to the liver. In the mouse, kidney effects were not observed; however, MCPD dimer did affect red blood cell indices as indicated by an approximately 10% decrease in erythrocyte count, hemoglobin concentration and hematocrit at the highest dose studied (400 ppm), and there was some indication of effects to the liver. Limitations, however, on the exposure duration and experimental design features of this study preclude drawing definitive interpretations with regards to the repeated exposure toxicity profile of MCPD dimer.

The C8 to C12 aromatic hydrocarbons in general show qualitatively similar toxicological properties as the C8 to C12 cycloalkenes (Cavender, 1994a,b). There are quantitative differences, however, between these hydrocarbons with the cycloalkenes producing greater toxicity at comparable dosages. The available information for solvents that are mixtures of C8 to C12 aromatic hydrocarbons indicate in general that this range of aromatic hydrocarbons are: of low to moderate acute toxicity producing transient CNS effects at high doses, of low repeated exposure systemic toxicity, not genotoxic, and not selectively toxic to the developing fetus, embryo, or reproductive system. The specific assessment of the available toxicology information for the C8 to C12 aromatic hydrocarbons is to be included in the International Hydrocarbon Solvents Consortium C9 Aromatic Hydrocarbon Solvents and C10+ Aromatic Hydrocarbon Solvents categories and will not be discussed more specifically in this test plan.

In addition to the existing information on DCPD as the dominant and or representative cycloalkene and on C8 to C12 aromatic hydrocarbons, there is also some limited information available on streams that consist of both kinds of hydrocarbons. And as expected, the toxicological properties of the streams are not dissimilar to that of this range of cycloalkenes and aromatic hydrocarbons. Resin-Former Feedstock, a test sample that consisted of 50-60% DCPD, 15-20% cyclopentadiene/methyl cyclopentadiene dimer, < 2% butadiene dimer, 10-12% styrene, < 2% xylene, and < 2% cyclopentadiene, exhibited low acute toxicity with CNS effects presented (Rausina, 1983; Gordon, 1983a). In addition, the stream was shown to possess low to moderate toxicity following repeated exposure with evidence of CNS (likely acute), liver and kidney (hydrocarbon nephropathy) effects, and generally an absence of genotoxic effects including an *in vivo* mouse micronucleus test (Rausina, 1984; Gordon, 1983b; Papciak and Goode, 1984; Brecher and Goode, 1984; Khan and Goode, 1984). The stream did exhibit positive activity in one *in vitro* system, a test of cell transformation in mouse embryo cells (Brecher and Goode, 1983). Details on these studies are provided in The Resin Oils and Cyclodiene Dimer Concentrates Category robust summaries. The Resin-Former Feedstock is believed to be representative of the High DCPD Resin Oil Stream.

One of the category streams, the DCPD Stream, in addition to containing approximately 50% DCPD, also contains a significant fraction of lighter hydrocarbons, primarily C5 olefins and paraffins. There is existing toxicology information for these substances and an assessment is planned for C5 mixed streams in support of the C5 Non-Cyclics Category that is also

sponsored by the Olefins Panel (A complete list of test categories sponsored by the Olefins Panel is provided in Table 9).

The expectation, therefore, is for the Resin Oils and Cyclodiene Dimer Concentrates Category of streams to have similar biological activity as demonstrated by DCPD and other physicochemically-similar carbon range cycloalkenes and aromatic hydrocarbons. Thus, the strategy of this screening level test plan for characterizing the human health hazards of this category include development and evaluation of data for DCPD and representative streams. These data are expected to be sufficient to satisfy the HPV requirements regarding the toxicity of all substances included in this category.

The details of the strategy are as follows:

1. Evaluation of existing data and new data resulting from other testing programs will be conducted for components or component families present in significant amounts in the streams of the Resin Oils and Cyclodiene Dimer Concentrates Category derived from:

   a. Existing data: See Table 3.

   b. DCPD: OECD SIDS.

   c. C8 to C12 aromatic hydrocarbons: Included in the International Hydrocarbon Solvents Consortium C9 Aromatic Hydrocarbon Solvents and C10+ Aromatic Hydrocarbon Solvents categories to be addressed in OECD SIDS (ICCA).

   d. Mixture of C5 olefins and paraffinic hydrocarbons: Included in the Olefins Panel C5 Non-Cyclics Category submitted November 2001.

2. To supplement the above data from other testing programs, testing is proposed for three representative streams taken from the two major category stream processes.

   One type of stream in the category is a C8-C12 hydrocarbon fraction that is distilled from pyrolysis gasoline. Streams of this type are either low in DCPD content (Low DCPD Resin Oil), or high in DCPD content (High DCPD Resin Oil). These streams contain DCPD in concentrations ranging from less than 1% to about 70% and have the background matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons.

   The second types of streams are the cyclodiene dimer concentrates (Cyclodiene Dimer Concentrates). In one processing arrangement for isolating these concentrates, a C5 fraction is distilled from pyrolysis gasoline, dimerized and then redistilled to produce a DCPD concentrate. In alternate processing, pyrolysis gasoline is distilled to isolate two other cylodiene dimer streams, a) DCPD/Codimers Concentrate, and 2) the MCPD Dimer stream. In these DCPD-containing streams, DCPD is in a mixture with codimers of comparable molecular weight.

   To bracket the two processes and the overall category of streams, testing is proposed

on three representative streams: 1) a high C8 to C12 resin oil matrix stream with low levels of DCPD (Low DCPD Resin Oil), 2) a representative stream from the dimer, non-resin oil matrix cyclodiene dimer concentrates process with DCPD and comparable molecular weight codimers (DCPD/Codimer Concentrate), and 3) a stream from the dimer, non-resin oil matrix cyclodiene dimer concentrates process high in MCPD Dimer. The toxicity findings from the testing of these streams and the existing information on DCPD are expected to characterize the expected toxicity properties of the High DCPD Resin Oils group of streams, which will not be tested, and the Resin Oils and Cyclodiene Dimer Category as a whole.

The specific testing proposed for the two streams follow:

a. Low DCPD Resin Oil

This stream is proposed to be tested to assess the toxicity of resin oil streams with a low (typically < 1%) DCPD content. This stream will be high in C8 to C12 cycloalkenes and aromatic hydrocarbon components. The stream will be tested as derived from the production facility, and not as a prepared mixture. The exact composition of the tested stream will be determined analytically at the time of testing. The proposed testing is a full SIDS human health test battery (except for acute toxicity which is not deemed informative for the HPV program). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

b. DCPD/Codimer Concentrate

A DCPD/Codimer Concentrate stream is proposed to be tested to assess the toxicity of a non-resin oil matrix stream with a mid-range content of DCPD (typically 40%) and comparable molecular weight codimers. The stream will be tested as derived from the production facility, and not as a prepared mixture. The exact composition of the tested stream will be determined analytically at the time of testing. The proposed testing is a full SIDS human health test battery (except for acute toxicity which is not deemed informative for the HPV program). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

c. MCPD Dimer

MCPD Dimer is proposed to be tested to assess the toxicity of a high purity C12 cycloalkene dimer. The stream will be tested as derived from the production facility, and not as a prepared mixture. The exact composition of the tested stream will be determined

analytically at the time of testing. The proposed testing is a full SIDS human health test battery (except for acute toxicity which is not deemed informative for the HPV program). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

The three streams are proposed for testing by the oral route of exposure. The most relevant routes of potential exposure to Resin Oils and Cyclodiene Dimer Concentrate Category streams are by inhalation and skin contact, but given the low volatility of the streams and variable dermal penetration rates of the stream components, these routes may not adequately characterize the streams' hazard potential. In addition, for DCPD SIDS testing, the oral route of exposure was utilized for the reproductive/developmental toxicity screening study; hence use of this same exposure route for the stream testing will provide for consistency in data interpretation.

The recommended testing together with existing data, data for components and component family under development by the Panel for other categories under the HPV program, by other HPV consortia, and by the OECD program, are expected to provide data to satisfy the HPV program requirements for the related hydrocarbon substances included in this category. This position is supported by the fact that previous testing and human experience with the category's major component, component families, and streams demonstrate a lack of biological activity that is outside of the range of typical hydrocarbon effects.

B. Human Health Effects - Stream Specific Rationales

The rationale for the test plan strategy specific to each stream in the Resin Oils and Cyclodiene Dimer Concentrates Category are presented below:

1. High DCPD Resin Oils

These streams are similar to the Low DCPD Resin Oil streams with the exception of the presence of high amounts of DCPD (range from 40-70%). Assessment of these streams is to be provided by the existing data for DCPD and the testing results of the Low DCPD Resin Oil stream. No additional testing of a stream from this group is proposed.

2. Low DCPD Resin Oils

A stream from this group is proposed to be tested in a complete SIDS battery of human health tests (except for acute toxicity) to assess the toxicity of resin oil streams with a very low (< 1%) DCPD content and significant amounts of C8 to C12 cyclodiene and aromatic hydrocarbons. Testing this stream will allow an assessment of 1) the impact of a very low level of DCPD on the toxicity of resin oil streams, 2) the hazards of a subset of the other components when the influence of DCPD is reduced or eliminated, and 3) the hazards of the High DCPD Resin Oils streams when this stream information is evaluated with the existing information for (pure) DCPD.

3. Resin Former

Resin Former streams are generally similar to the Low DCPD Resin Oil stream except for containing low levels of DCPD. The typical stream content of DCPD is about 7%. With this minimal composition of DCPD, the toxicity of the Resin Former streams are expected to be characterized by the testing results of the Low DCPD Resin Oil stream. No HPV testing of a stream from this group is proposed.

4. DCPD Concentrate

The DCPD Concentrate streams contain a high content of DCPD (typically 75% with range from 70 to 90%) in the non-resin oil matrix of comparable molecular weight cycloalkene dimers and smaller amounts of lighter, < C8, cycloalkenes, alkenes, aliphatic, and aromatic hydrocarbons. Assessment of these streams is to be provided by the existing data for DCPD. No additional testing of a stream from this group is proposed.

5. DCPD, High purity

The DCPD, High purity stream is similar, if not equivalent, to the DCPD assessed in the OECD SIDS program. With respect to the HPV program endpoints, the human health toxicity profile of this stream is expected to be the same as that of the OECD SIDS assessment for DCPD. No additional HPV testing of a stream from this group is proposed.

6. DCPD Purge Stream

This stream is a concentrates process stream with a mid-level of DCPD (average 18%) and amounts of comparable molecular weight codimers. With the lower composition of DCPD, the toxicity of the DCPD Purge Stream is expected to be conservatively characterized by the testing results of the DCPD/Codimer Concentrates stream (average 40% DCPD). Similar to the resin oils, this stream also contains a low amount (about 10%) of C8 aliphatics and aromatics; however, at these levels their potential impact on toxicity is considered minimal. No additional HPV testing of a stream from this group is proposed.

7. MCPD Dimer

The MCPD Dimer stream is a concentrate process stream with typical purity of 90% for MCPD Dimer. MCPD Dimer is also present at low levels in several of the resin oils and cyclodiene dimer concentrates streams. A MCPD Dimer stream is proposed to be tested in a complete SIDS battery of human health tests (except for acute toxicity). Testing this stream will allow an assessment of 1) the hazards of MCPD Dimer due to it's high purity in the stream, 2) the comparative hazards of MCDP Dimer to DCPD for the overall assessment of C8 to C12 cycloalkenes, and 3) the hazards of other category streams (e.g., Resin Former, High DCPD Resin Oil, DCPD Purge Stream, and DCPD/Codimer Concentrate) that contain an amount of MCPD Dimer.

8. DCPD Stream

This stream typically contains about 50% DCPD and the remaining lighter hydrocarbons, primarily C5 olefins and paraffins. There is existing toxicology information for these substances and also an assessment planned for C5 mixed streams in support of the C5 Non-Cyclics Category also sponsored by the Panel. The toxicity of the DCPD Stream therefore can be characterized through the existing and new data from DCPD, the DCPD/Codimer Concentrates stream, and the C5 Non-Cyclics Category. No additional testing of this stream is proposed at this time.

9. DCPD/Codimer Concentrate

A stream from this group is proposed to be tested in a complete SIDS battery of human health tests (except for acute toxicity) to assess toxicity of the Cyclodiene Dimer Concentrates streams. The DCPD/Codimer Concentrate stream typically contains about 40% DCPD and the remaining components are predominantly codimers of cyclopentadiene with methylcyclopentadiene, piperylene and butadiene. MCPD dimer is also present at about 10%. The components of this stream are essentially the same as the dimers and codimers found in the High DCPD Resin Oils, but with the ratio of the concentrations of codimers to DCPD much higher. Testing this stream will allow an assessment of: 1) the impact of DCPD in the non-resin oil matrix on the toxicity of Cyclodiene Dimer Concentrates streams, 2) the hazards of Cyclodiene Dimer Concentrates streams when this stream information is evaluated with the existing information for (pure) DCPD, and 3) the hazards of Cyclodiene Dimer Concentrates streams that contain a significant amount of codimers.

C. Physicochemical Properties

The physicochemical (PC) endpoints in the HPV Chemical Program include:

- Melting Point
- Boiling Point
- Vapor Pressure
- Water Solubility
- Octanol/Water Partition Coefficient (K_{ow})

Although some of these data for product streams in the Resin Oils and Cyclodiene Dimer Concentrates Category exist, not all of these endpoints are defined, and a comprehensive and consensus database for chemicals that represent product streams in this category does not exist. Therefore, calculated PC data for selected component chemicals in this category will be developed using a computer model to provide a consistent, representative data set. In addition, selected physicochemical data will be developed for three products, a Low DCPD Resin Oil product, a Dicyclopentadiene (DCPD)/Codimer Concentrate product, and a MCPD Dimer product.

Calculated PC data for selected component chemicals in the Resin Oils and Cyclodiene Dimer Concentrates Category will be developed using the EPIWIN© computer model (EPIWIN, 1999) as discussed in the US EPA document entitled *The Use of Structure-Activity Relationships (SAR) in the High Production Volume Chemicals Challenge Program* (EPA, 1999a). The use of computer modeling for the development of these data is justified since components of the streams in this category are all chemically related and are expected to exhibit relatively similar environmental properties. In addition, for all the chemicals selected to represent products in this category, a calculated dataset provides a common method in the development of these values.

Boiling point, melting point, and vapor pressure ranges will be determined using the MPBPVP subroutine in EPIWIN. K_{ow} and water solubility will be calculated using KOWIN and WSKOW subroutines, respectively. There is more information on calculating data for the HPV chemical program in the EPA document titled, *The Use of Structure-Activity Relationships (SAR) in the High Production Volume Chemicals Challenge Program*.

Because the HPV substances covered under the Resin Oils and Cyclodiene Dimer Concentrates Category testing plan are mixtures containing differing compositions, it is not possible to develop or calculate a single numerical value for each of the physicochemical properties. For example, a product that is a mixture of chemicals does not have a melting point, but rather a melting range. Calculated values for physicochemical properties will be represented as a range of values according to the product's component composition and based on the results of computer modeling.

Robust summaries characterizing the PC endpoints will be prepared upon completion of the proposed testing, and will include the calculated data and testing results.

D. Ecotoxicity

The aquatic toxicity endpoints for the HPV Chemical Program include:

- Acute Toxicity to a Freshwater Fish
- Acute Toxicity to a Freshwater Invertebrate
- Toxicity to a Freshwater Alga

Acute fish toxicity data are available for a product in the Resin Oils and Cyclodiene Dimer Concentrates Category. There are no invertebrate or alga toxicity data available for products in this category. However, there are read across data to initially characterize these two endpoints for chemicals found in products from this category and complex products that contain chemicals found in products from this category. The use of data from selected read across materials to products in this category can be justified for the following reasons:

- Individual chemicals and complex products used for read across purposes contain a chemical class or combinations of chemical classes (i.e., olefins, and aromatics) that are found in products from this category.

- Individual chemicals and complex products used for read across purposes have a carbon number or carbon number range that falls within the range of carbon numbers found in products from this category.
- Individual chemicals and complex products used for read across purposes as well as the products in this category are composed of chemicals that all act by a similar mode of toxic action.

The data in Table 4 compare the range of product compositions (i.e., carbon number, chemical class, weight percent) in the Resin Oils and Cyclodiene Dimer Concentrates Category to products that will be used to initially characterize the aquatic toxicity of this category. This comparison illustrates the similarity in carbon number ranges between products in this category and the selected products with read across data. The data in Tables 5, 6, and 7 establish the range of toxicity that products in this category would be expected to demonstrate, based on the read across data.

The aquatic toxicity data presented in this test plan fall within a narrow range of values regardless of their varying chemical class content and carbon number range. This is not unexpected, because the constituent chemicals of products in this category are neutral organic hydrocarbons whose toxic mode of action is non-polar narcosis. The mechanism of short-term toxicity for these chemicals is disruption of biological membrane function (Van Wezel and Opperhuizen, 1995), and the differences between measured toxicities (i.e., LC/LL50, EC/EL50) can be explained by the differences between the target tissue-partitioning behavior of the individual chemicals(Verbruggen *et al*., 2000).

The existing fish toxicity database for narcotic chemicals supports a critical body residue (CBR, the internal concentration that causes mortality) of between approximately 2-8 mmol/kg fish (wet weight)(McCarty and Mackay, 1993; McCarty *et al*., 1991), supporting the assessment that these chemicals have comparable potencies. When normalized to lipid content, the CBR is approximately 50 umol of hydrocarbon/g of lipid for most organisms (Di Toro *et al*., 2000). Because the products in this category are all complex mixtures containing relatively similar series of homologous chemicals, their short-term toxicities are expected to fall within the range of toxicity demonstrated by the individual chemicals, as well as comparable products summarized in this test plan. Therefore, the existing data are believed to form a sufficiently robust dataset to initially characterize the aquatic toxicity endpoints in the HPV Chemical Program for this category.

The fish and invertebrate acute and alga toxicity values for individual chemicals and products that are complex mixtures of chemicals [used as read across data to products in this category (Tables 5, 6, 7), as well as a product from this category] fall within a range of 1.0-21.3 mg/L. Because the products in the Resin Oils and Cyclodiene Dimer Concentrates Category will range in alkene and/or aromatic carbon number content within approximately C8 to C12, a range in toxicity for products in this category is expected to be comparable to the range of data summarized in Tables 5, 6, and 7.

As suggested by the experimental data, this category is expected to exhibit a moderate range of acute toxicity to fish and invertebrates, and a moderate range of toxicity to algae. For

representative chemicals, complex products, and one category product, acute fish toxicity values range between 2.6 and 18.0 mg/L for four species (Table 5). For representative chemicals and complex products, acute invertebrate toxicity values range between 1.0 and 21.3 mg/L for one species (Table 6). For representative complex products, alga toxicity values range between 1 and 3 mg/L (for biomass and growth rate endpoints) for one species, while the alga NOELR values were 1.0 mg/L (for biomass and growth rate endpoints) (Table 7).

To confirm that products from the streams in this category will exhibit a range of toxicity equivalent to the acute fish and invertebrate, and alga toxicity results in Tables 5, 6, and 7, data for these endpoints will be developed for three products:

- a Low DCPD Resin Oil product that contains a lower level of DCPD
- a DCPD/Codimer Concentrate product that contains a mid level of DCPD and comparable molecular weight codimers
- a MCPD Dimer (methylcyclopentadiene dimer) product that contains approximately 90% MCPD Dimer

The DCPD/Codimer Concentrate and Low DCPD Resin Oil products will contain mid range and low concentrations of DCPD, respectively. The remaining chemical constituents for these two products will vary in composition, but can include a selection of chemicals listed in Table 2. The majority of chemicals in these products will have carbon numbers in the range of eight to ten. It is anticipated that the aquatic toxicity of these two products will be similar because, as discussed above, all the component chemicals act by the same mode of action and have equivalent potencies.

The MCPD Dimer stream was selected because unlike most other products in this category, it is a relatively pure product and represents the highest molecular weight compounds in the range of chemical carbon numbers found in this category. As such, it is projected to have the highest Kow (octanol-water partition coefficient) value of the predominant chemicals in this category, and may demonstrate a high level of aquatic toxicity for the endpoints in the HPV Chemicals program. However, it is calculated to have relatively low water solubility, and because of possible water solubility limitations, it may not produce effects in the three aquatic test species. Therefore, proposed testing for this product will follow a tiered approach as follows:

- The first test will be the alga toxicity test.
- If MCPD Dimer demonstrates toxicity to an alga, an acute invertebrate test will be conducted.
- If MCPD Dimer demonstrates toxicity to an invertebrate, an acute fish test will be conducted.
- If MCPD Dimer does not demonstrate toxicity to an alga, the acute fish and invertebrate tests will not be conducted because it is highly unlikely that MCPD Dimer will cause acute effects to these organisms.

The fish and invertebrate acute and alga toxicity tests will follow OECD Guidelines 203, 202, and 201, respectively. When appropriate, the test procedures will also apply the OECD guidance for testing complex substances as described in *Guidance Document on Aquatic Toxicity Testing of Difficult Substances and Mixture*s (OECD, 1999).

E. Environmental Fate

The environmental fate endpoints in the HPV Chemical Program include:

- Biodegradation
- Photodegradation
- Hydrolysis
- Fugacity

Although biodegradation data are not available for products in the Resin Oils and Cyclodiene Dimer Concentrates Category, there are data for selected component chemicals of those products, as well as for complex products, that can be used to initially characterize the potential biodegradability of this category. The complex product values are for substances composed of a range of chemicals with regard to carbon numbers and chemical classes (i.e., alkenes, alkylbenzenes, and naphthalenes). As suggested by the experimental data, products in this category are expected to exhibit a significant extent of biodegradation. To confirm and characterize the potential of products in this category to biodegrade, three products will be tested.

Data and/or information in the form of a technical discussion will be provided for photodegradation. Chemicals in this category are not subject to hydrolysis at measurable rates, therefore information for this endpoint will be summarized in a technical review document.

Equilibrium models are used to calculate chemical fugacity, which can provide information on where a chemical is likely to partition in the environment. These data are useful in identifying environmental compartments that could potentially receive a released chemical. Fugacity data can only be calculated for individual chemicals. For the HPV Chemical Program, environmental partitioning data will be developed for selected component chemicals of the products in this category.

A preliminary evaluation of chemicals in the Resin Oils and Cyclodiene Dimer Concentrates Category suggests that they will partition largely to the air and soil, and therefore their fate in these compartments is of environmental interest. Because the air phase may be a compartment that could potentially receive many of the component chemicals in this category, data characterizing their potential for physical degradation in the atmosphere will be developed (this is discussed below under photodegradation).

1. Biodegradation

Data for constituent chemicals of products in this category and for complex products suggest that resin oil and cyclodiene dimer concentrate products have the potential to biodegrade to a significant extent (Table 8). The complex products contain chemicals that can be found in products from this category. The carbon number of products in the Resin Oils and Cyclodiene Dimer Concentrates Category ranges primarily between C8 to C12. Single chemicals and complex products with chemicals that have carbon numbers in this range and are contained by products in this category have been shown to biodegrade from 29 to 100% after 14 or 28 days.

The data from the majority of studies in Table 8 were developed using a manometric respirometry test procedure (OECD guideline 301F). This procedure uses continuously stirred, closed systems, which is recommended when assessing the potential biodegradability of chemically complex, poorly water soluble, and volatile materials like those in this category. Stirring is recommended when evaluating products containing several chemicals, some of which may have limited water solubility.

A predominant chemical component for several products in this category is dicyclopentadiene (DCPD). Therefore, the potential biodegradability of this chemical will largely influence the relative biodegradability of several products in this category. Because there are no reliable data for this component and because it can be a significant component in products from this category, evaluating two products containing DCPD will provide sufficient data to characterize the biodegradability of products in this category that contain DCPD.

To fully characterize the potential biodegradability of products in this category, the Panel proposes to test three products, a DCPD/Codimer Concentrate product that contains a mid level of DCPD and comparable molecular weight codimers, a Low DCPD Resin Oil product that contains a lower level of DCPD, and a MCPD Dimer product. The testing procedure for these products will follow the OECD Guideline 301F, Manometric Respirometry Biodegradation Test. The data from the proposed testing will be compared to the data discussed above to confirm that products in this category are as readily biodegraded as suggested by those data.

2. Photodegradation – Photolysis

Direct photochemical degradation occurs through the absorbance of solar radiation by a chemical substance. If the absorbed energy is high enough, then the resultant excited state of the chemical may lead to its transformation. Simple chemical structures can be examined to determine whether a chemical has the potential for direct photolysis in water. First order reaction rates can be calculated for some chemicals that have a potential for direct photolysis using the procedures of Zepp and Cline (1977).

To develop information or data that will characterize the potential of products in this category to undergo direct photochemical degradation, the existing product chemical

composition data and composition data that will be developed for the three products identified for biodegradation testing will be evaluated together to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. The UV light absorption of the selected chemicals will then be evaluated to identify those chemicals with a potential to degrade in solution. When possible, first order reaction rates will be calculated for those chemicals identified to have a potential for direct photolysis in water. The results of the calculations will be summarized in a technical discussion for this endpoint. If instead, a low potential for direct photolysis is suggested by the evaluation, a technical discussion will be prepared to summarize the findings.

3. Photodegradation – Atmospheric Oxidation

Photodegradation can be measured (the US EPA identifies OECD test guideline 113 as a test method) (EPA, 1999b) or estimated using models accepted by the US EPA (EPA, 1999a). An estimation method accepted by the US EPA includes the calculation of atmospheric oxidation potential (AOP). Atmospheric oxidation as a result of hydroxyl radical attack is not direct photochemical degradation, but rather indirect degradation. AOPs can be calculated using a computer model. Hydrocarbons, such as those in the Resin Oils and Cyclodiene Dimer Concentrates Category, have the potential to volatilize to air where they can react with hydroxyl radicals (OH-).

The computer program AOPWIN (atmospheric oxidation program for Microsoft Windows) (EPIWIN, 1999) is used by the US EPA OPPTS (Office of Pollution Prevention and Toxic Substances). This program calculates a chemical half-life based on an overall OH- reaction rate constant, a 12-hr day, and a given OH- concentration. This calculation will be performed for representative component chemicals of products in the Resin Oils and Cyclodiene Dimer Concentrates Category. The existing product chemical composition data and composition data that will be developed for the three products identified for biodegradation testing will be evaluated together to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. The resulting calculations will be summarized in a robust summary for this endpoint.

4. Hydrolysis

Hydrolysis of an organic chemical is the transformation process in which a water molecule or hydroxide ion reacts to form a new carbon-oxygen bond. Chemicals that have a potential to hydrolyze include alkyl halides, amides, carbamates, carboxylic acid esters and lactones, epoxides, phosphate esters, and sulfonic acid esters (Neely, 1985).

Chemical stability in water can be measured (EPA identifies OECD test guideline 111 as a test method) or estimated using models accepted by the EPA (EPA, 1999a). An estimation method accepted by the EPA includes a model that can calculate hydrolysis rate constants for esters, carbamates, epoxides, halomethanes, and selected alkylhalides. The computer program HYDROWIN (aqueous hydrolysis rate program for Microsoft windows) (EPIWIN,

1999) is used for this purpose by OPPTS. However, all of the chemical structures included in the Resin Oils and Cyclodiene Dimer Concentrates Category are hydrocarbons. That is, they consist entirely of carbon and hydrogen. As such they are not expected to hydrolyze at a measurable rate.

A technical document will be prepared that discusses the potential hydrolysis rates of chemicals in this category, the nature of the chemical bonds present, and the potential reactivity of this class of chemicals with water.

5. Chemical Transport and Distribution in the Environment - Fugacity Modeling

Fugacity based multimedia modeling can provide basic information on the relative distribution of chemicals between selected environmental compartments (i.e., air, soil, sediment, suspended sediment, water, biota). The U.S. EPA has acknowledged that computer modeling techniques are an appropriate approach to estimating chemical partitioning (fugacity is a calculated endpoint and is not measured). A widely used fugacity model is the EQC (Equilibrium Criterion) model (Mackay *et al*., 1996). The U.S. EPA cites the use of this model in its document titled *Determining the Adequacy of Existing Data* (EPA, 1999b), which was prepared as guidance for the HPV Program.

In its document, the U.S. EPA states that it accepts Level I fugacity data as an estimate of chemical distribution values. The input data required to run a Level I model include basic physicochemical parameters; distribution is calculated as percent of chemical partitioned to 6 compartments described above within a defined unit world. Level I data are basic partitioning data that allow for comparisons between chemicals and indicate the compartment(s) to which a chemical is likely to partition.

The EQC Level I is a steady state, equilibrium model that utilizes the input of basic chemical properties including molecular weight, melting point, vapor pressure, and water solubility to calculate distribution within a unit world. This model will be used to calculate distribution values for representative component chemicals in products from this category. Existing product chemical composition data and composition data that will be developed for the three products identified for biodegradation testing will be evaluated together to select a subset of chemicals that adequately represents products in this category. The selection process will consider chemical carbon number range, hydrocarbon type, and chemical structure. A computer model, EPIWIN version 3.04 (EPIWIN, 1999), will be used to calculate the physicochemical properties needed to run the Level I EQC model. The resulting calculations will be summarized in a robust summary for this endpoint.

IV. TEST PLAN SUMMARY

The following evaluations, testing, modeling, and technical discussions are proposed for the Resin Oils and Cyclodiene Dimer Concentrates Category (Table 3) as follows:

- Conduct tests for SIDS human health and environmental fate and effects endpoints (except acute toxicity) on Low DCPD Resin Oil, a stream typically containing less than 1% DCPD content in the resin oil matrix of C8 to C12 cycloalkenes and aromatic hydrocarbons (exact composition to be determined at the time of testing). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422), a fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the Low DCPD Resin Oil stream.

  A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include selected chemicals in this stream. Measured physicochemical data specifically for a product in this stream will be developed and will include boiling point range, vapor pressure, and octanol-water partition coefficient range. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components.

- Conduct tests for SIDS human health and environmental fate and effect endpoints (except acute toxicity) on DCPD/Codimer Concentrate, a stream typically containing approximately 40% DCPD and the remainder codimers of cyclopentadiene with MCPD, piperylene, and butadiene (exact composition to be determined at the time of testing). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422), a fish acute toxicity test (OECD Guideline 203), an invertebrate immobilization acute toxicity test (OECD Guideline 202), an alga growth inhibition test (OECD Guideline 201), a manometric respirometry biodegradation test (OECD Guideline 301F). A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the DCPD Concentrate stream.

  A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated

for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category will include selected chemicals in this stream. Measured physicochemical data specifically for a product in this stream will be developed and will include boiling point range, vapor pressure, and octanol-water partition coefficient range. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components.

- Conduct tests for SIDS human health endpoints (except acute toxicity) on MCPD Dimer, a stream with high purity (typically 90%) MCPD Dimer (exact composition to be determined at the time of testing). The following tests are proposed: A bacterial gene mutation test (Ames test, OECD Guideline 471), a mouse micronucleus test for chromosome aberrations (OECD Guideline 474), and a rat combined repeated dose/reproductive and developmental effects/neurotoxicity screen (OECD Guideline 422).

  For environmental fate and effects endpoints, the following tests are proposed for MCPD Dimer: An alga growth inhibition test (OECD Guideline 201) and a manometric respirometry biodegradation test (OECD Guideline 301F). Additional aquatic toxicity testing will depend on the outcome of the alga study and may include a fish acute toxicity test (OECD Guideline 203) and/or an invertebrate immobilization acute toxicity test (OECD Guideline 202).

  A technical discussion will be prepared on the potential of chemicals in products from this category to undergo hydrolysis. That discussion will include a review of selected chemicals contained in the MCPD Dimer stream. A technical discussion will be prepared on the potential of chemicals in products from this category to undergo photolysis. That discussion will include calculations of direct photodegradation rates for chemicals that have been identified as having the potential to exhibit a significant rate of photolysis. Indirect photodegradation rates will be calculated for representative chemicals in this category and will include selected chemicals in this stream. Fugacity calculations (chemical distribution) using a computer model will be performed for selected chemicals from this category and will include chemicals in this stream. Measured physicochemical data specifically for a product in this stream will be developed and will include boiling point range, vapor pressure, and octanol-water partition coefficient range. Calculated data will also be developed for these three endpoints, as well as melting point range and water solubility range based on selected chemical components.

- Evaluate all data for human health and environmental fate and effects endpoints obtained from testing in this program for the Low DCPD Resin Oil stream, DCPD/Codimer Concentrate stream, and MCPD Dimer stream, along with existing and new data for components and streams generated in other testing programs and prepare a technical discussion in terms of their representation of potential human and environmental health effects for streams in this category.

Summaries of the results will be developed once the data and analyses are available. This test plan is expected to provide data sufficient to satisfy HPV program requirements regarding the human health effects and environmental fate and effects endpoints for the category. After all indicated testing has been completed, all data will be evaluated to determine whether the data support the category or if additional data or testing is warranted.

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Table 1.
CAS Numbers used in the Resin Oils and Cyclodiene Dimer Concentrates Category.

CAS Number	CAS Number Description
26472-00-4	4,7-Methano-1H-indene, 3a,4,7,7a-tetrahydrodimethyl-
68477-40-7	Distillates, petroleum, cracked stripped steam-cracked petroleum distillates, C10-12 fraction
68477-54-3	Distillates, petroleum, steam-cracked, C8-12 fraction
68477-53-2[1]	Distillates, petroleum, steam-cracked, C5-12 fraction
68478-08-0	Naphtha, petroleum, light steam-cracked, C5-fraction, oligomer conc.
68478-10-4	Naphtha, petroleum, light steam-cracked, debenzenized, C8-16-cycloalkadiene conc.
68516-20-1	Naphtha, petroleum, steam-cracked middle arom.
68527-24-2	Naphtha, petroleum, light steam-cracked arom., C5-12 cycloalkadienefraction, polymers
68527-26-4	Naphtha, petroleum, light steam-cracked, debenzenized
68603-02-1	Distillates, petroleum, thermal cracked naphtha and gas oil, dimerized

1 CAS number 64742-49-0 Naphtha, petroleum, hydrotreated light was submitted for the corresponding stream in one company's TSCA IUR submission but as part of the review for the HPV program, it was determined that CAS number 68477-53-2 Distillates, petroleum, steam-cracked, C5-12 fraction more appropriately describes the material.

Table 2.
Typical Composition Ranges (Percent) for
Resin Oils and Cyclodiene Dimer Concentrates Streams.

(See notes 1-3 at the end of this table)

Component Name	High DCPD Resin Oil	Low DCPD Resin Oil	Resin Former	DCPD Conc.	DCPD, High Purity	MCPD Dimer	DCPD Purge	DCPD Stream	DCPD/ Codimer Conc.
Isoprene (2-Methyl-1,3-Butadiene)				0.5					
Pentane				1 - 1.5					
Cis-2-Pentene				3.5					
1,3-Cyclopentadiene	2			0 - 3	0.2 - 1.5				
1,3-Pentadiene				3					
Cyclopentene				4.8					
Cyclopentane				0.8 - 1					
C5 Olefins and Paraffins								35 - 45	
C6-C8 Non-Aromatics				1 - 7					
CPD or MCPD Codimers with Vinyl Aromatics			8.2						
Benzene	0 – 0.01			0 - 2.5		0.01			
C7 Cyclics						1			
Toluene				0 - 2					
Xylenes, Mixed		1 - 5	1.2						
Styrene	2 - 6	0 - 11	4.5						
Allylbenzene			2.5						
Propylbenzene	0.5 - 1	1.4	2						
C9 Substituted Benzenes		20							
Ethyltoluenes	1 - 2.5	4	7						
1,3,5-Trimethylbenzene (Mesitylene)	0 - 1								
Alpha-Methylstyrene	0.5 - 3.5	1 - 5	4.5						
o-,p-,m-Methylstyrene		12							
1,2,4-Trimethylbenzene (Pseudocumene)		1 - 10							
Trimethylbenzenes	1 - 2.3	5 - 20	4						
Cyclopentadiene/Isoprene Codimers	0 - 1								
Cyclopentadiene/1,3-Pentadiene Codimers	0.6 - 1.6								9.9
Piperylene-MCPD Codimers									5.7
Butadiene-CPD Codimers									6.3
Butadiene-MCPD Codimers							6		
Isoprene-cyclopentadiene codimers				11					
Cyclopentadiene / Methylcyclopentadiene Codimers	1 - 7		5.3				10		24
Dicyclopentadiene	40 - 70	0.5	6.7	70 - 90	94 – 99.5	0.1	18		41
DCPD and codimers of C5s								55-60	
MCPD-C7 Codimers							5		
C5-MCPD Codimers							18		
C5-CPD Codimers							5		
Tetrahydro-Indiene							5		
C8 aliphatics and aromtics							10		

Component Name	High DCPD Resin Oil	Low DCPD Resin Oil	Resin Former	DCPD Conc.	DCPD, High Purity	MCPD Dimer	DCPD Purge	DCPD Stream	DCPD/ Codimer Conc.
Vinyl Toluene	4 – 14	5 - 25	13.6						
Vinyl Aromatics	10								
Isobutylbenzene			1.4						
Remaining C8+ Olefins and Aromatic Components, Including Various Oligimers of CPD and MCPD	2.5 - 15								
C10 & C11 Codimers of C5 & C6					0.2 - 4				
Propenylbenzene		1.5							
Beta-Methylstyrene	0.5 - 1.5	1 - 5	6.4						
Indane (Indan)		1 - 1.5							
C10 Substituted Benzenes		3 - 7							
Indene	2 - 9	5 - 20	13.4						
Butylbenzene	0 - 1.5		2						
C10 Substituted Styrene		4 - 10							
Dimethylstyrene		2.1							
Methyl Indenes		5 - 30	1.1						
Methyl Indane		1							
C10-C11 Alkylbenzenes		10 - 30							
Methylcyclopentadiene Dimers	0.5 - 1.2		5.2			90	18		9.6
Acyclic Dienes					2 - 2.3	1			
Trimers				1.1	0 - 2		4		2.4
Naphthalene	0.5	1 - 8	1						
C6 - C9 Saturates								0 - 5	

NOS not otherwise specified

Note 1: The composition data shown above are composites of reported values.
Note 2: The balance of these streams is expected to be other hydrocarbons that have boiling points in the range of the listed components.
Note 3: The listed highs and lows should not be considered absolute values for these limits. They are instead the highs and lows of the reported values.

Table 3. Assessment Plan for Resin Oils and Cyclodiene Dimer Concentrates Category Under the Program. (Robust summaries for existing studies are submitted separately.)

	Human Health Effects						Ecotoxicity				Environmental Fate			
Stream Description	**Acute Toxicity**	**Genetic Point Mut.**	**Genetic Chrom.**	**Sub-chronic**	**Develop-mental**	**Reproduction**	**Acute Fish**	**Acute Invert.**	**Algal Toxicity**	**Physical Chem.[1]**	**Photo-deg.**	**Hydro-lysis**	**Fugacity**	**Biodeg.**
High DCPD Resin Oils (DCPD Content = 42-70%)	A	A	A	RA	RA	RA	A	RA	RA	RA/CM	TD/CM	TD	CM	RA
Low DCPD Resin Oils (DCPD Content = < 1%)	NA	T	T	T	T	T	T	T	T	T/CM	TD/CM	TD	CM	T
Resin Former (DCPD Content = 7%)	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
DCPD Concentrate (DCPD Content = 70 – 90%)	NA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
DCPD, High Purity (DCPD Content = 95%)	A	A	A	A	A	A	A	A	RA	RA/CM	TD/CM	TD	CM	RA
DCPD Purge (DCPD Content = 20%)	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
MCPD Dimers (MCPD Content = 90%)	A	RA	RA	RA	RA	RA	T*	T*	T	T/CM	TD/CM	TD	CM	T
DCPD Stream (DCPD Content = 50%)	RA	RA	RA	RA	RA	RA	RA	RA	RA	RA/CM	TD/CM	TD	CM	RA
DCPD/Codimer Concentrate DCPD Content = 41%	NA	T	T	T	T	T	T	T	T	T/CM	TD/CM	TD	CM	T

1 Measured data for selected physicochemical endpoints will be identified in conjunction with calculated data to characterize this category.

A Adequate existing data available
CM Computer Modeling proposed
NA Not Applicable
TD Technical Discussion proposed
T Testing proposed
T* Testing dependent on outcome of alga study
RA Read Across (see Sec. III.B)

Table 4.
Approximate Weight Percent and Carbon Number Range Comparison of the Predominant Hydrocarbons in Products from the Resin Oils and Cyclodiene Dimer Concentrates Category and Chemically Complex Products with Aquatic Toxicity Data used to Read Across to the Category.
(The complex products are not in this category.)

Substance Name	Olefins		Aromatics		Paraffins	
	% (wt.)	C # (a)	% (wt.)	C # (a)	% (wt.)	C # (a)
Products in Resin Oils and Cyclodiene Dimer Concentrates Category (b)	**1-34**	**5-9**	**>40-100**	**6-11**	**>4-75**	**5-10**
Alkenes, C7-9, C8 Rich	**100**	**7-9**	**0**	**-**	**0**	**-**
C8-C10 Aromatics, Predominantly C9 Aromatics	**0**	**-**	**>97**	**8-10**	**<3**	**-**
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	**0**	**-**	**>94**	**10-14**	**<6**	**-**

a Predominant carbon number range
b Approximate weight percent and carbon number ranges of the predominant chemical components for products contained by this category; % compositions may not total 100%.

Table 5.
Acute Fish Toxicity Data for Selected Chemicals, Chemically Complex Products, and a Product in this Category (Resin Former Feedstock).
The Chemical and Complex Product Data are used to Read Across to Products from the Resin Oils and Cyclodiene Dimer Concentrates Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (96-hr, mg/L)	REFERENCE
Alkenes, C7-9, C8 Rich	7-9(b)	*Oncorhynchus mykiss*	LL50 = 8.9	HOP*
o-Xylene	8	*Pimephales promelas*	LC50 = 16.4	IHSC**
p-Xylene	8	*Oncorhynchus mykiss*	LC50 = 2.6	IHSC**
p-Xylene	8	*Pimephales promelas*	LC50 = 8.9	IHSC**
Ethylbenzene	8	*Pimephales promelas*	LC50 = 12.1	IHSC**
Resin Former Feedstock	8-10(b)	*Oncorhynchus mykiss*	LL50 = 10.6	Robust summary provided with this test plan
Resin Former Feedstock	8-10(b)	*Lepomis macrochirus*	LL50 = 13.5	Robust summary provided with this test plan
1,2,4-Trimethylbenzene	9	*Pimephales promelas*	LC50 = 7.7	IHSC**
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	*Oncorhynchus mykiss*	LL50 = 18.0	IHSC**
Dicyclopentadiene	10	*Oryzias latipes*	LC50 = 3.7(c)	Robust summary provided with this test plan
C8-C14 Aromatics, Predominantly alkyl Naphthalenes and Naphthalene	10-12(b)	*Oncorhynchus mykiss*	LL50 = 3.0	IHSC**

a Endpoint is mortality; LC = Lethal Concentration; LL = Lethal Loading; NOELR = No Observed Effect Loading Rate; values cited as "concentration" are based on measured values
b Predominant carbon number or range
c 48-hour study
* Robust summary from the Higher Olefins Panel: C6, C7, C8, C9, and C12 Internal Olefins and C16 and C18 Alpha Olefins Category Test Plan (submitted)
** Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

Table 6.
Acute Invertebrate Toxicity Data for Selected Chemicals and Chemically Complex Products.
The Chemical and Complex Product Data are used to Read Across to Products from the Resin Oils and Cyclodiene Dimer Concentrates Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (48-hr, mg/L)	REFERENCE
o-Xylene	8	*Daphnia magna*	EC50 = 1.0	IHSC*
m-Xylene	8	*Daphnia magna*	EC50 = 4.7	IHSC*
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	*Daphnia magna*	EL50 = 21.3	IHSC*
Naphthalene	10	*Daphnia magna*	EL50 = 16.7(c)	IHSC*
Dicyclopentadiene	10	*Daphnia magna*	EL50 = 10.5(c)	Robust summary provided with this test plan
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	*Daphnia magna*	EL50 = 3.0	IHSC*

a Endpoint is immobility; EC = Effect Concentration; EL = Effect Loading; NOELR = No Observed Effect Loading Rate; values cited as "concentration" are based on measured values
b Predominant carbon number or range
c Based on nominal values
* Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

Table 7.
Alga Toxicity Data for Chemically Complex Products
used to Read Across to Products from the Resin Oils and Cyclodiene Dimer Concentrates Category.

CHEMICAL / PRODUCT	CARBON NUMBER	ORGANISM	AQUATIC TOXICITY (a) (72-hr, mg/L)	REFERENCE
C8-C10 Aromatics, Predominantly C9 Aromatics	8-10(b)	*Pseudokirchneriella subcapitata(c)*	EbL50 = 2.6 ErL50 = 2.9 NOELRb = 1.0 NOELRr = 1.0	IHSC*
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	*Pseudokirchneriella subcapitata*	EbL50 = 1-3 ErL50 = 1-3 NOELRb = 1.0 NOELRr = 1.0	IHSC*

a Endpoint is growth inhibition; EbL = Effect Loading for biomass; ErL = Effect Loading for growth rate; NOELRb = No Observed Effect Loading Rate for biomass; NOELRr = No Observed Effect Loading Rate for growth rate
b Predominant carbon number
c Formally known as *Selenastrum capricornutum*
* Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)

Table 8.
Read Across data used to Characterize the Biodegradability of Products in the Resin Oils and Cyclodiene Dimer Concentrates Category.
The Data are for Chemicals Contained by Products in this Category and Chemically Complex Products not in this Category. (The complex products contain chemicals found in products from this category.)

CHEMICAL / PRODUCT	CARBON NUMBER	PERCENT BIODEGRADATION(a) (28 days)	REFERENCE
Alkenes, C7-C9, C8 Rich	7-9	29	HOP*
o-Xylene	8	70	IHSC**
p-Xylene	8	89	IHSC**
Styrene	8	100 (14 days)(c)	***
C8-C10 Aromatics, Predominantly C9 Alkylbenzenes	9(b)	78	IHSC**
C8-C14 Aromatics, Predominantly Alkyl Naphthalenes and Naphthalene	10-12(b)	61	IHSC**

a OECD 301F, manometric respirometry test
b Predominant carbon number or range
c BOD test
* Robust summary from the Higher Olefins Panel: C6, C7, C8, C9, and C12 Internal Olefins and C16 and C18 Alpha Olefins Category Test Plan (submitted)
** Robust summary from the International Hydrocarbon Solvents Consortium: Contained in selected SIAR (to be submitted)
*** Chemicals Inspection and Testing Institute, Japan. 1992.

Table 9.
American Chemistry Council Olefins Panel Sponsored
HPV Test Categories

Category Number	Category Description
1	Crude Butadiene C4
2	Low Butadiene C4
3	C5 Non-Cyclic
4	Propylene Streams
5	High Benzene Naphthas
6	Low Benzene Naphthas
7, 8, 9	Resin Oil and Cyclodiene Dimer Concentrates
10	Fuel Oils

Appendix I

ETHYLENE PROCESS DESCRIPTION

A. The Ethylene Process

1. Steam Cracking

Steam cracking is the predominant process used to produce ethylene. Various hydrocarbon feedstocks are used in the production of ethylene by steam cracking, including ethane, propane, butane, and liquid petroleum fractions such as condensate, naphtha, and gas oils. The feedstocks are normally saturated hydrocarbons but may contain minor amounts of unsaturates. These feedstocks are charged to the coils of a cracking furnace. Heat is transferred through the metal walls of the coils to the feedstock from hot flue gas, which is generated by combustion of fuels in the furnace firebox. The outlet of the cracking coil is usually maintained at relatively low pressure in order to obtain good yields to the desired products. Steam is also added to the coil and serves as a diluent to improve yields and to control coke formation. This step of the ethylene process is commonly referred to as "steam cracking" or simply "cracking" and the furnaces are frequently referred to as "crackers".

Subjecting the feedstocks to high temperatures results in the partial conversion of the feedstock to olefins. In the simplest example, feedstock ethane is partially converted to ethylene and hydrogen. Similarly, propane, butane, or the liquid feedstocks are also converted to ethylene. While the predominant products produced are ethylene and propylene, a wide range of additional products are also formed. These products range from methane (C1) through fuel oil (C12 and higher) and include other olefins, diolefins, aromatics and saturates (naphthenes and paraffins).

2. Refinery Gas Separation

Ethylene and propylene are also produced by separation of these olefins from refinery gas streams, such as from the light ends product of a catalytic cracking process or from coker offgas. This separation is similar to that used in steam crackers, and in some cases both refinery gas streams and steam cracking furnace effluents are combined and processed in a single finishing section. These refinery gas streams differ from cracked gas in that the refinery streams have a much narrower carbon number distribution, predominantly C2 and/or C3. Thus the finishing of these refinery gas streams yields primary ethylene and ethane, and/or propylene and propane.

B. Products of the Ethylene Process

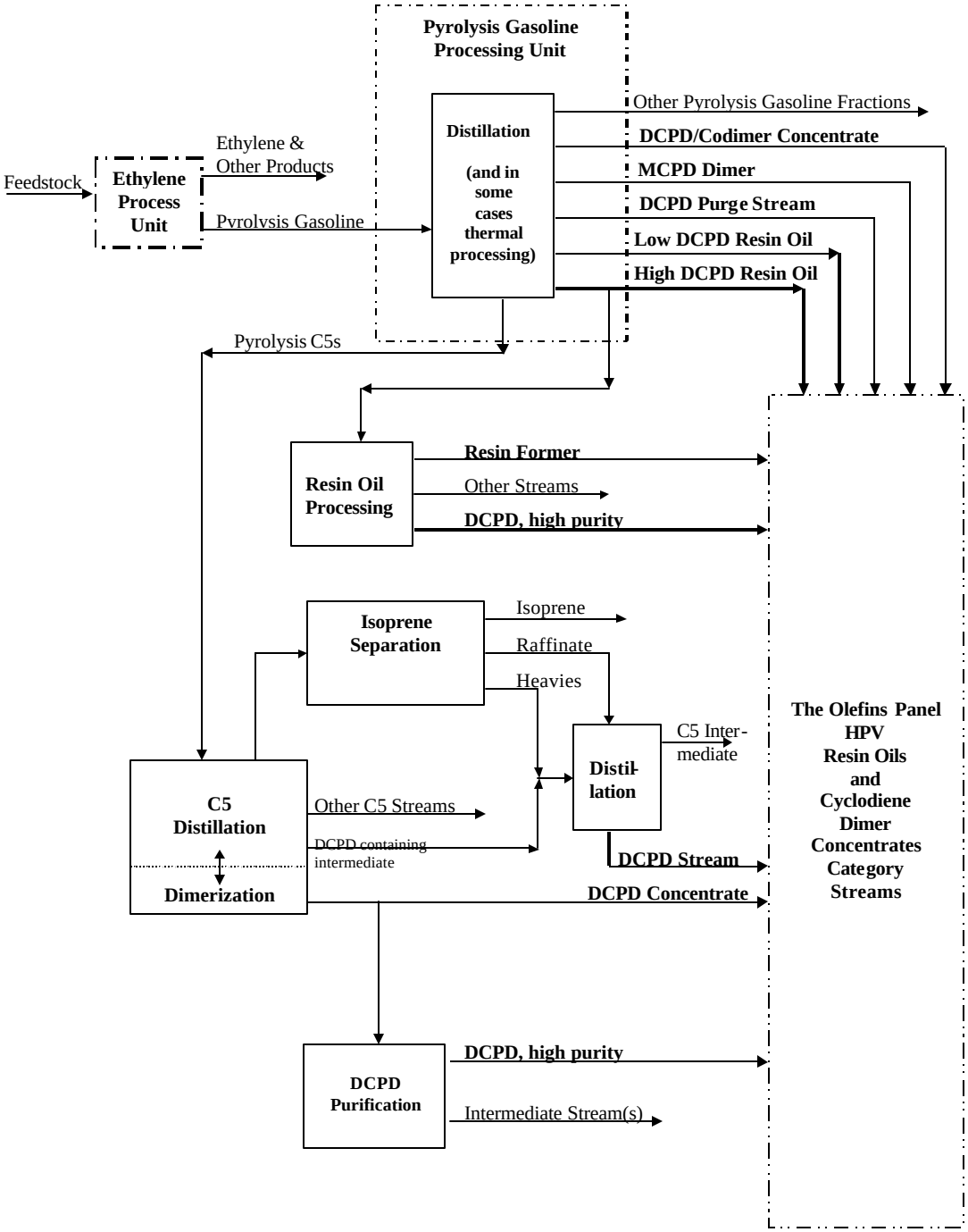
The intermediate stream that exits the cracking furnaces (i.e., the furnace effluent) is forwarded to the finishing section of the ethylene plant. The furnace effluent is commonly referred to as "cracked gas" and consists of a mixture of hydrogen, methane, and various hydrocarbon compounds with two or more carbon atoms per molecule (C2+).

The relative amount of each component in the cracked gas varies depending on what feedstocks are cracked and cracking process variables. Cracked gas may also contain relatively small concentrations of organic sulfur compounds that were present as impurities in the feedstock or were added to the feedstock to control coke formation. The cracked gas stream is cooled, compressed and then separated into the individual streams of the ethylene process. These streams can be sold commercially and/or put into further steps of the process to produce additional materials. In some ethylene processes, a liquid fuel oil product is produced when the cracked gas is initially cooled. The ethylene process is a closed process and the products are contained in pressure systems.

The final products of the ethylene process include hydrogen, methane (frequently used as fuel), and the high purity products ethylene and propylene. Other products of the ethylene process are typically mixed streams that are isolated by distillation according to boiling point ranges and then further processed. It is a subset of these mixed streams that make up the constituents of the Resin Oils and Cyclodiene Dimer Concentrates Category.

The chemical process operations that are associated with the process streams in the Resin Oils and Cyclodiene Dimer Concentrates Category are shown in Figure 1.

Figure 1. Chemical Process Operations Associated with Process Streams in the Resin Oils and Cyclodiene Dimer Concentrates Category.



AR201-13434B

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Dicyclopentadiene (DCPD), CAS #77-73-6. approx. 97% endo- and approx. 1% cyclopentadiene. Clear colorless liquid at room temperature.
Method	
Method/guideline followed	Not specified
Type (test type)	Acute
GLP	Yes
Year	1981
Species/Strain	Rat, Fischer 344
Sex	Males and females
No. of animals per sex per dose	6
Vehicle	Air
Route of administration	Whole Body Inhalation
Test Conditions	Animals were housed 2/cage in stainless steel cages and received water and powdered chow diet ad lib except during exposure. A 12hr light/dark photoperiod cycle was maintained. Animals were kept in their respective cages during exposure. Exposure was for a single 6hr period on day 1 and sacrifice was on day 15. DCPD vapor was generated inside a heated pyrex tube to achieve complete vaporization while keeping temperature below the point (35^0C) at which fracturing to monomer occurred. Chamber concentrations of DCPD and cyclopentadiene (CPD) were monitored by gas chromatography/flame ionization detection with detection limit of 0.05ppm for both compounds. The actual exposure concentrations were 46, 130, 260 and 557ppm. This study was conducted to obtain a definitive LC_{50} value for DCPD exposure that was not confounded by fracturing of DCPD. Previous publications give conflicting LC_{50} values that might have been caused by loss of DCPD via fracturing. In the present study, CPD was below the detection limit. Animals were observed daily for clinical signs. All rats were necropsied for gross lesions. LC_{50} was calculated by the method of moving averages.
Results	
LC_{50} with confidence limits.	LC_{50} males: 284 (236-341)ppm; females 353 (322-387)ppm
Remarks	Rats of both sexes in the 557ppm group showed loss of righting reflex, impaired gait, stereotypic behavior, labored breathing, nasal discharge, convulsions and death. At 260ppm, both sexes showed stereotypic behavior, respiratory difficulty and nasal discharge. In rats dying from exposure, convulsions were observed immediately before death. At 130ppm, the only sign observed in both sexes, was a somewhat sluggish movement. No treatment-related clinical signs were observed in rats exposed to 46ppm. In rats that did not die during the study, all clinical signs cleared by day 2. There were no gross pathological effects noted at necropsy.
Conclusions (study author)	LC_{50} males: 284 (236-341)ppm; females 353 (322-387)ppm The LC_{50}s reflect the effects of DCPD. Results were not confounded by fracturing of DCPD into CPD.
Data Quality	
Reliability	**2.** Reliable with restrictions. The actual numbers of rats dying at the various exposure levels were not presented in the report.
References	Gad, S.C., Snellings, W.M., Egan, G.F., Nachreiner, D.J., Evancheck, R.E. and Dickey, C.L. 1981. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Doc. #81-MR-R2694. Bushy Run Research Center, Export, PA for Exxon Chemical Corp. Snellings, W.M. 1981. 9-day rat and mouse inhalation study. Report #43-527. Bushy Run Research Center, Export PA for Exxon Corp., Linden, NJ (test article description) Gad, S.C., Egan, G.F., Nachreiner, D.J., and Evancheck, R.E. 1980. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Abst. #130 from the 19th

	Annual meeting of the Society of Toxicology Bevan, C., Snellings, W.M., Dodd, D.E. and Egan, G.F. 1992. Subchronic toxicity study of dicyclopentadiene vapor in rats. Toxicol. and Ind. Health 8:353-367. (detailed discussion of results)
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Dicyclopentadiene (DCPD), CAS #77-73-6. approx. 97% endo- and approx. 1% cyclopentadiene. Clear colorless liquid at room temperature.
Method	
Method/guideline followed	Not specified
Type (test type)	Acute
GLP	Yes
Year	1981
Species/Strain	Mouse, B6C3F1
Sex	Males and females
No. of animals per sex per dose	6
Vehicle	Air
Route of administration	Whole Body Inhalation
Test Conditions	Animals were housed 2/cage in stainless steel cages and received water and powdered chow diet ad lib except during exposure. A 12hr light/dark photoperiod cycle was maintained. Animals were kept in their respective cages during exposure. Exposure was for a single 6hr period on day 1 and sacrifice was on day 15. DCPD vapor was generated inside a heated pyrex tube to achieve complete vaporization while keeping temperature below the point (35^0C) at which fracturing to monomer occurred. Chamber concentrations of DCPD and cyclopentadiene (CPD) were monitored by gas chromatography/flame ionization detection with detection limit of 0.05ppm for both compounds. The actual exposure concentrations were 46, 130, 260 and 557ppm. This study was conducted to obtain a definitive LC_{50} value for DCPD exposure that was not confounded by fracturing of DCPD. Previous publications give conflicting LC_{50} values that might have been caused by loss of DCPD via fracturing. In the present study, CPD was below the detection limit. Animals were observed daily for clinical signs. All mice were necropsied for gross lesions. LC_{50} was calculated by the method of moving averages.
Results	
LC_{50} with confidence limits.	LC_{50} males: 143 (130-157)ppm; females 130 (103-153)ppm
Remarks	Mice of both sexes in the 557ppm group showed loss of righting reflex, impaired gait, stereotypic behavior, labored breathing, clear nasal discharge, and deaths. At 260ppm, mice of both sexes showed stereotypic behavior, respiratory difficulty, impaired gait, loss of coordination and convulsions prior to death. At 130ppm, mice displayed irregular breathing and stereotypic behavior; females also showed loss of coordination and slight tremors. No treatment-related clinical signs were observed in mice exposed to 46ppm. There were no gross pathological effects noted at necropsy.
Conclusions (study author)	LC_{50} males: 143 (130-157)ppm; females 130 (103-153)ppm The LC_{50}s reflect the effects of DCPD. Results were not confounded by fracturing of DCPD into CPD.
Data Quality	
Reliability	**2.** Reliable with restrictions. The actual numbers of mice dying at the various exposure levels were not presented in the report.
References	Gad, S.C., Snellings, W.M., Egan, G.F., Nachreiner, D.J., Evancheck, R.E. and Dickey, C.L. 1981. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Doc. #81-MR-R2694. Bushy Run Research Center, Export, PA for Exxon Chemical Corp. Snellings, W.M. 1981. 9-day rat and mouse inhalation study. Report #43-527. Bushy Run Research Center, Export PA for Exxon Corp., Linden, NJ (test article description) Gad, S.C., Egan, G.F., Nachreiner, D.J., and Evancheck, R.E. 1980. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Abst. #130 from the 19th

	Annual meeting of the Society of Toxicology Bevan, C., Snellings, W.M., Dodd, D.E. and Egan, G.F. 1992. Subchronic toxicity study of dicyclopentadiene vapor in rats. Toxicol. and Ind. Health 8:353-367. (detailed discussion of results)
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Genetic Toxicity - in Vitro

Test Substance	Dicyclopentadiene resin grade (DCPD), CAS #77-73-6, purity 75%; stable at room temperature; clear light yellow liquid
Test substance	
Method	
Method/guideline followed	OECD guideline 471 (adopted 7/21/97);EEC Annex V of Directive 67/548/EEC, Part B 13/14: Mutagenicity: reverse mutation assay using bacteria (draft Brussels 7/23/99)
Type µ	Bacterial reverse mutation
System of testing	Salmonella typhimurium and Escherichia coli with and without metabolic activation
GLP	Yes
Year	2000
Species/Strain	S. typhimurium TA98, TA100, TA1535, TA1537 and E. coli WP2uvrA.
Metabolic activation	Yes
Species and cell type	Wistar male rat liver (S9 fraction) prepared at Notox
Quantity	5% S9 fraction in 1st experiment; 10% S9 fraction in 2nd experiment
Induced or not induced	Aroclor 1254 induced, rats were given 500mg/kg ip 5 days prior to sacrifice
Concentrations tested	1st exp.:-S9 0, 1 (Sal.only, except TA100), 3, 10, 33, 100, (TA100 and E.coli only) 333, 1000, 3330 and 5000µg/plate; +S9 (5%) 0, 3, 10, 33, 100, 167 (Sal. only except TA100), (TA100 and E.coli) 333, 1000, 3330 and 5000µg/plate. 2nd exp.:-S9 0, 1 (Sal only) 3, 10, 33, 66 (E.coli only) and 100µg/plate; +S9 (10%) 0, 3 (Sal. only), 10, 33, 100 167 (Sal. only); (E. coli only) 333 and 666µg/plate
Statistical Methods	None. Criteria for positive response were at least a 3-fold (TA1535, TA 1537, TA98, E.coli WP2) or 2-fold (TA100) dose related increase over solvent control values for the respective strains with or without metabolic activation. Positive or negative responses should be reproducible in at least one independent repeat experiment.
Remarks for Test Conditions	Dicyclopentadiene test solutions were prepared in ethanol immediately prior to use. Salmonella strains and E. coli WP2 (approx. 10^9 cells/ml) were exposed to either test solution or ethanol ±S9 in 3 plates/dose/strain by the preincubation method. The range-finding test in TA100 and E. coli WP2 over a range of 3-5000µg/plate ±S9 was incorporated into the 1st experiment. TA98, TA1535 and TA1537 were tested at 1-100µg/plate –S9 and 3-167ug/plate +S9 (5%) in the 1st experiment. The highest concentration of test solution used in the 2nd experiment was the level at which there was significant inhibition of bacterial growth in TA100 and E.coli WP2. Culture vessels containing 0.1ml bacterial culture, 0.05ml test substance in ethanol or ethanol alone for the control, and 0.5ml S9 mix (5% S9 in exp.1 and 10% S9 in exp. 2) or 0.5ml of 0.1M phosphate buffer were combined and incubated with shaking (70rpm) for 30 min at 37^0C. After preincubation, solutions were added to 3ml molten (45^0C) top agar and poured on minimal agar plates. Plates were incubated upside down in the dark at 37^0C for 48 hrs. Revertant colonies were counted automatically (Protos model 50000) or manually if < 40 colonies/plate were present, and conditions of background lawn were evaluated. Positive control compounds were: -S9 sodium azide (NaA, 1ug/plate) for TA1535; 9-aminoacridine (9-AC, 60µg/plate) for TA1537; daunomycine (DM, 4µg/plate) for TA98; methyl methanesulfonate (MMS, 650µg/plate) for TA100 and 4-nitroquinoline N-oxide (4-NQO, 1µg/plate) for E.coli WP2; +S9: 2-aminoanthracene (2-AA) 2.5, 1.0, 5.0 and 10.0µg/plate for TA1535 & TA1537, TA98, TA100 and E. coli WP2, respectively.
Results	In the range-finding test presented as part of experiment 1, using TA100 and E.coli WP2 uvrA at concentrations of 3-5000µg/plate with 5% S9in mix, or no metabolic activation, DCPD precipitate in top agar at concentrations of 1000µg and above+S9. . Precipitate was present +S9 at 3330 and 5000µg/plate at the beginning of incubation but was not apparent at the end of incubation. In TA100 plates±S9, extreme inhibition of background lawn and appearance of microcolonies occurred from 333-500µg/plate; in E. coli WP2, extreme inhibition began at 100µg/plate-S9 and at 333µg/plate+S9. No increase in revertant colonies was observed at any non-toxic doses ±S9 (e.g. TA100-S9: 82, 84, 87, 71 and 37
Genotoxic effects	

	avg. revertants/plate and +S9: 97, 100, 89, 92,and 58 avg. revertants/plate at 0, 3, 10, 33 and 100ug/plate, respectively). Salmonella strains TA1535, TA1537 and TA98 were tested at concentrations of 0, 1, 3, 10, 33 and 100µg/plate–S9 and 0, 3, 10, 33, 100 and 167µg/plate +S9 (5% in mix). No precipitate was observed in top agar or on plates at any dose level. Extreme toxicity to background lawns was observed at 100µg/plate-S9 and at 167µg/plate+S9 for all strains. No increase in number of revertant colonies compared to solvent controls was observed (e.g. TA98 –S9: 14, 13, 14, 16 and 8 avg. revertants/plate at 0, 1, 3, 10 and 33µg/plate; +S9: 20, 13, 19, 19 and 10 avg. revertants/plate at 0, 3, 10, 33 and 100µg/plate, respectively). In experiment 2, 10% S9 fraction (v/v) was employed in metabolically activated cultures. Salmonella strains TA1535, TA1537, TA98, TA100 were exposed to 1-100µg/plate –S9 and 3-167µg/plate +S9; E.coli WP2 was exposed to 3-100µg/plate –S9 and 10-666µg/plate +S9. No precipitate was observed in top agar solutions or on plates. Toxicity to background lawn and reduction in revertant colonies was observed at 100µg/plate at a moderate level in Salmonella strains and slightly in E. coli WP2 –S9; slight inhibition of background lawn was observed at 167µg/plate in Salmonella stains and slight to moderate inhibition was observed in E. coli WP2 at 333 and 666ug/plate +S9. No increase in revertant colonies was observed at any dose level. (e.g. TA100-S9: 96, 107, 88, 99, 78 and 57 avg. revertants/plate at 0, 1, 3, 10, 33 and 100µg/plate; +S9: 105, 117, 100, 112, 82 and 90 avg. revertants/plate at 0, 3, 10, 33, 100 and 167µg/plate. E.coli WP2 -S9: 8, 6, 13, 8, 8 and 10 avg. revertants/plate at 0, 3, 10, 33, 66 and 100µg/plate; +S9: 8, 8, 10, 9, 10 and 7 avg. revertants/plate at 0, 10, 33, 100 and 333 and 666µg/plate). Positive control compounds responded appropriately: -S9: NaA 118, 139; 9-AC 95, 160; DM 404, 421; MMS 629, 589; 4-NQO 857,644 avg. revertants/plate in experiments 1 and 2, respectively, and +S9: 2-AA 198, 217; 206,146; 494, 385; 1089, 581; 287, 189 avg. revertants/plate in experiments 1 and 2 for strains TA1535, TA1537, TA98, TA100 and E.coli WP2). DCPD resin grade did not induce a dose-related or 2-fold or 3-fold increase in the number of revertant colonies in any Salmonella strain or in E. coli WP2 uvrA ±S9 in two independent assays.
Conclusions (contractor)	Dicyclopentadiene resin grade did not induce a significant increase in revertant colonies in Salmonella strains or in E. coli WP2 uvrA with or without rat liver metabolic activation at any dose level and is not considered a mutagen in this test system.
Data Quality *Reliabilities*	**1.** Reliable without restrictions
Reference	Verspeek-Rip, C.M. 2000. Evaluation of the mutagenic activity of dicyclopentadiene resin grade in the Salmonella typhimurium reverse mutation assay and the Escherchia coli reverse mutation assay (Preincubation test) with independent repeat. Proj. #284265. Notox B.V., The Netherlands. For Dow Chemical Co., Dow Europe S.A. – Horgen
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Genetic Toxicity - in Vitro

Test Substance	
Test substance	Dicyclopentadiene, CAS # 77-73-6 (3a, 4, 7, 7a-Tetrahydro-4, 7-methanoindene), purity 95%.
Method	
Method/guideline followed	Japan: Guidelines for Screening Mutagenicity Testing on Chemicals
Type	Mammalian chromosomal aberration
System of testing	Chinese hamster lung cells
GLP	Yes
Year	1998
Species/Strain	Chinese hamster lung (CHL/IU) cells
Metabolic activation	Yes
Species and cell type	Rat liver (Strain not specified)
Quantity	Not specified
Induced or not induced	Phenobarbital and 5,6-benzoflavone induced (Treatment not specified)
Concentrations tested	0.0, 0.014, 0.029, 0.057mg/ml –S9 24 hr continuous treatment; or short-term treatment (duration not specified); 0.0, 0.03, 0.05, 0.10mg/ml +S9 short-term treatment.
Statistical Methods	Not specified. Japanese guidelines state "test substance is considered to be positive when assay cultures show a significantly higher incidence of cells with chromosomal aberrations as compared with the negative control, and when this effect is reasonably reproducible or dose-dependent."
Remarks for Test Conditions	Summarized information only. Test material was prepared in acetone and administered to Chinese hamster lung cells with and without metabolic activation in 2 cultures per dose level. The test material was incubated with CHL cells in growth phase (usually 10^5 cells/ml growth medium) for 24 hrs continuous treatment without metabolic activation and for a shorter duration (Japanese guidelines indicate 3-6 hrs) with and without metabolic activation from rat liver S9, at 37^0C in a 5% CO_2 in air humidified atmosphere. In accordance to Japanese guidelines, the dose range was selected to produce 50% or greater inhibition of cell growth or mitosis at the maximum dose level. Following short-term exposure, cultures containing S9 mix were washed and fresh medium added. All cultures were treated with Colcemid® approximately 2 hrs prior to harvest to arrest dividing cells in metaphase. Cells were fixed and slides prepared for chromosome analysis (Giemsa is a standard stain for metaphase chromosome spreads). All slides, including positive and negative controls were coded before microscopic analysis. Japanese guidelines specify that 100 metaphase spreads should be counted and analyzed for structural aberrations (gaps, breaks, exchanges) and polyploids, and the percentage of cells with aberrations (with and without gaps) calculated. The negative control vehicle was acetone; positive control compounds were mitomycin C –S9 and cyclophosphamide + S9 (doses not specified).
Results	
Genotoxic effects	Dicylcopentadiene did not induce structural chromosomal aberrations or polyploidy in CHL/IU cells up to a concentration causing more than 50% cell growth inhibition with or without metabolic activation. Structural chromosomal aberrations were marginally induced at the highest dose –S9, 0.057mg/ml, after 24 hr continuous exposure.
Conclusions	
(contractor)	Dicyclopentadiene did not induce significant cytogenetic damage to mammalian cells in vitro under conditions of this assay. Although some marginal chromosome damage occurred at the highest –S9 dose after 24 hrs continuous exposure, the test material was confirmed to be negative for clastogenicity in an in vitro micronucleus assay (details not cited).
Data Quality	
Reliabilities	**2.** Reliable with restrictions. Limited detail; summary information sheet only provided by Japan Chemical Industry Ecology-Toxicology and Information Center (JETOC). Study was performed according to Japanese test guidelines for mutagenicity and GLP at a reputable laboratory.

Reference	JETOX 1998. Special Issue #3; No. 32 (March, 1998), Tokyo, Japan. Study performed at Hatano Research Institute, Food and Drug Safety Center, Hadanishi, Kanagawa, Japan. Handbook of Existing and New Chemical Substances, 8th Ed. 1999. Supervised by Chemical Products Safety Division, Basic Industries Bureau, The Ministry of International Trade and Industry, Japan.
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Repeated Dose Toxicity

Test Substance	Dicyclopentadiene (DCPD), CAS #77-73-6, >95% endo-DCPD, 0.5%iso-DCPD and approx. 1% cyclopentadiene (CPD). Clear colorless liquid at room temperature.
Remarks	
Method	
Method/guideline followed	Not specified
Test type	Subchronic
GLP	Yes
Year	1982
Species	Rat
Strain	Fischer 344
Route of administration	Inhalation
Duration of test	26 wks
Doses/concentration levels	0, 1.0, 5.1 and 51ppm (actual)
Sex	Males and females
Exposure period	2, 6 and 13 wks
Frequency of treatment	6hr/day, 5 days/wk
Control group and treatment	Male and female rats, Filtered air
Post exposure observation period	4 and 13 wks
Statistical methods	Analysis of variance, Bartlett's test, Duncan's multiple range test, F-test, Student's t-test, Cochran t-test (applied when appropriate)
Test Conditions	Rats (30-34 days of age) were individually housed in stainless steel wire mesh suspended cages and maintained on a 12hr light/dark cycle. Chow diet and water were provided ad lib. Room temperature and relative humidity were maintained between 68-72^{0}F and 40-60%, respectively; during exposure, ranges were 70-79^{0}F and 39-68%, respectively. DCPD vapor was generated by heating the liquid in a Pyrex tube using a minimum amount of heat to prevent decomposition and formation of CPD. Filtered air was used to dilute the vapor prior to introduction into the chamber. Chamber concentrations were monitored by gas chromatography/flame ionization detection. Each dose group consisted of 51 rats/sex. Nine rats/sex/dose were scheduled for sacrifice the day after 2, 6, and 13 wks of exposure and 4 and 13 wks post-exposure. In addition, 3 rats/sex/dose were sacrificed after 13 wk exposure and 3/sex/dose after 13 wks post-exposure for electron microscopy of the kidneys. Rats were observed for clinical signs before and after each exposure, and daily during the recovery period. Body wt was recorded at initiation, weekly during both the exposure period and the first 5 wks of recovery, and then every 2 wks. High dose rats received opthalmoscopic examination before sacrifice. Hematology and serum chemistry analyses were performed on all rats prior to sacrifice after 2, 6 and 13wk exposure and 4 and 13wk post-exposure with blood from the orbital sinus. Erythrocyte count, hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin and concentration, and total/differential white blood cell counts were determined. Serum was analyzed for creatinine, urea nitrogen, calcium, phosphrous, chloride, alanine aminotransferase, aspartate aminotransferase, total protein, albumin, total bilirubin, alkaline phosphatase, glucose and osmolality. Urinalysis was performed weekly for the first 4 wks of the study and prior to sacrifice. Semi-quantitative assessments were made of pH, protein, glucose, bilirubin, urobilinogen and blood, and quantitative assessment of volume, specific gravity, osmolality, color, turbidity, creatinine, calcium, phosphorous, chloride, sodium and potassium. Food and water consumption were also measured. A urine concentration test was performed on day 6 (males and females) and on day 83 (males only) in rats deprived of water for 16 hrs. Necropsies were conducted on all rats. Kidneys, lungs, liver and testes were weighed. Adrenals, bone and bone marrow (sternum), brain, epididymides, eyes, heart, kidneys, larynx, liver, lungs, lymph nodes (mediastinal), muscle (gastrocnemeous), nasal turbinates, parathyroids, pituitary, sciatic nerve, spleen, testes, thymus, thyroids, trachea, urinary bladder and gross lesions were preserved for microscopic evaluation. All rat kidneys and urinary bladders were examined microscopically; other organs were only examined microscopically in control and high dose rats sacrificed after 13 wks of exposure. Electron

	microscopic examination was performed on rat kidneys fixed in gluteraldehyde/formaldehyde for 24hr and post-fixed in 1% osmium tetroxide, and embedded in Epon 812.
Results	
NOAEL (NOEL)	Males<1.0ppm (renal tubule hyperplasia, epithelial cell casts); Females=51ppm
LOAEL (LOEL)	Males=1.0ppm (renal tubule hyperplasia, epithelial cell casts); Females: not reached at 51ppm
Remarks	No treatment related mortality occurred. No consistent pattern of clinical signs was observed during the study, and during exposure, all rats appeared normal. There were no treatment related changes in body wt or food consumption. Males in the 51ppm group had a significant decrease in urine specific gravity and osmolality, occasionally associated with increased urine volume and/or increased water consumption; these effects were exposure, dose and time-related. Analysis of urine sediment uncovered epithelial cells indicative of renal damage in all test article dose groups. Dose-related epithelial cell casts were found at all DCPD levels during the study but not during recovery. These effects were not seen in females. At 51ppm, males showed altered excretion rates for calcium (decrease), sodium (decrease) and potassium (increase). Urine concentrating ability was also decreased at 51ppm in males but not in females. Serum chemistries were minimally altered: calcium (increase at 51 and 5.1ppm), alanine aminotransferase (decrease at 51 and 5.1ppm). No biologically significant changes in hematological parameters were seen. Mild conjunctivitis was seen in several rats during DCPD exposure in the 51 and 5.1ppm groups. No significant effects were seen at necropsy. Male rats at 51ppm had significant increases in relative liver wt and both absolute and relative kidney wts; these effects cleared during recovery. DCPD related organ wt changes were not seen in females. The only histopathological finding related to DCPD exposure was in male rat kidney. At 5.1 and 51ppm males accumulated hyaline droplets in the proximal convoluted tubular epithelial cells by the 10th DCPD exposure, and resolved during recovery. Males exposed to 5.1 and 51ppm had tubular hyperplasia, tubule proteinosis and basement membrane thickening. The frequency of kidney tubular protein accumulation after 30 exposures increased significantly in 1.0ppm males. On several occasions, parameters measured in the 1.0ppm males changed in the same direction as in the higher dose groups but the magnitude of change was lower, and hence, not significant. Examples of occurrences were for relative kidney wt., decreased urine osmolality, decreased sodium, increased potassium excretion, and kidney tubular hyperplasia. Electron microscopy supported the light microscopy observations.
Conclusions (study authors)	The only major effect observed was a male rat specific nephropathy, characteristic of the hyaline droplet nephropathy produced by a diverse group of compounds.
Quality Reliabilities	**1.** Reliable without restrictions
References	Dodd, D.E., Longo, L.C. and Eisler, D.L. 1982. Ninety-day vapor inhalation study on rats and mice. Report #44-520. Bushy Run Research Center, Export, PA, for Exxon Corp. East Millstone, NJ Bevan, C., Snellings, W.M., Dood, D.E. and Egan, G.F. 1992. Subchronic toxicity study of dicyclopentadiene vapor in rats. Toxicol. and Ind. Health 8: 353-67. Gad, S.C., Snellings, W.M., Egan, G.F., Nachreiner, D.J., Evanscheck, R.E. and Dickey, C.L. 1981. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Doc. #81-MR-R2694. Bushy Run research Center, Export, PA for Exxon Chemical Corp. Snellings, W.M. 1981. 9-day rat and mouse inhalation study. Report #43-527. Bushy Run Research Center, Export PA for Exxon Corp., Linden, NJ (test article description). Gad, S.C., Egan, G.F., Nachreiner, D.J., and Evanscheck, R.E. 1980. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Abst. #130 from the 19th Annual meeting of the Society of Toxicology
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Repeated Dose Toxicity

Test Substance	Dicyclopentadiene (DCPD), CAS #77-73-6, >95% endo-DCPD, 0.5%iso-DCPD and approx. 1% cyclopentadiene (CPD). Clear colorless liquid at room temperature.
Remarks	
Method	
Method/guideline followed	Not specified
Test type	Subchronic
GLP	Yes
Year	1982
Species	Mouse
Strain	B6C3F1
Route of administration	Inhalation
Duration of test	26 wks
Doses/concentration levels	0, 1.0, 5.1 and 51ppm (actual)
Sex	Males and females
Exposure period	2, 6 and 13 wks
Frequency of treatment	6hr/day, 5 days/wk
Control group and treatment	Male and female mice, Filtered air
Post exposure observation period	4 and 13 wks
Statistical methods	Analysis of variance, Bartlett's test, Duncan's multiple range test, F-test, Student's t-test, Cochran t-test (applied when appropriate)
Test Conditions	Mice (30-34 days of age) were individually housed in stainless steel wire mesh suspended cages and maintained on a 12hr light/dark cycle. Chow diet and water were provided ad lib. Room temperature and relative humidity were maintained between 68-72^{0}F and 40-60%, respectively; during exposure, ranges were 70-79^{0}F and 39-68%, respectively. DCPD vapor was generated by heating the liquid in a Pyrex tube using a minimum amount of heat to prevent decomposition and formation of CPD. Filtered air was used to dilute the vapor prior to introduction into the chamber. Chamber concentrations were monitored by gas chromatography/flame ionization detection. Each dose broup consisted of 45 mice/sex. Nine mice/sex/dose were scheduled for sacrifice after 2, 6, and 13 wks of exposure and 4 and 13 wks post-exposure.. Mice were observed for clinical signs before and after each exposure, and daily during the recovery period. Body wt was recorded at initiation, weekly during both the exposure period and the first 5 wks of recovery, and then every 2 wks. High dose mice received opthalmoscopic examination before sacrifice. Hematology and serum chemistry analyses were performed on all mice prior to sacrifice after 2, 6 and 13wk exposure and 4 and 13wk post-exposure with blood from the orbital sinus. Erythrocyte count, hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin and concentration, and total/differential white blood cell counts were determined. Serum was analyzed for creatinine, urea nitrogen, calcium, phosphrous, chloride, alanine aminotransferase, aspartate aminotransferase, total protein, albumin, total bilirubin, alkaline phosphatase, glucose and osmolality. Necropsies were conducted on all mice. Kidneys, lungs, liver and testes were weighed. Adrenals, bone and bone marrow (sternum), brain, epididymides, eyes, heart, kidneys, larynx, liver, lungs, lymph nodes (mediastinal), muscle (gastrocnemeous), nasal turbinates, parathyroids, pituitary, sciatic nerve, spleen, testes, thymus, thyroids, trachea, urinary bladder and gross lesions were preserved for microscopic evaluation. Organs were only examined microscopically in control and high dose mice sacrificed after 13 wks of exposure.
Results	
NOAEL (NOEL)	Males and Females = 5.1ppm
LOAEL (LOEL)	Males and Females = 51.0ppm (deaths)
Remarks	Ten males and 9 female mice exposed to 51ppm DCPD died during the study; whereas no more than 2 mice died at any other level. No significant clinical signs or body wt changes were noted prior to death. The likely cause of death appeared to be pulmonary congestion and possibly renal failure. These effects were not seen in mice sacrificed at the end of the

	study. During exposure, a few of the mice at 51 and 5.1ppm showed coordination loss and/or decreased activity. Males and females in the 51ppm group showed significant elevation in body wt gain that returned to control values during recovery. No consistent changes in serum chemistry values were found. No biologically significant effects on hematology and no alterations in blood cell differential counts were observed. Mild conjunctivitis was seen in one male mouse at 51ppm. No lesions were found at gross necropsy. No exposure related changes in organ wt were observed and no histopathological effects were noted in either sex.
Conclusions (study authors)	Approximately 20% of both sexes of mice died at 51ppm, apparently of pulmonary congestion, but similar effects were not seen in mice sacrificed on schedule. A significant body wt gain was also observed, only in female mice, at 51ppm (40% of the LD_{50}). No other biologically significant effects were observed.
Quality Reliabilities	**1.** Reliable without restrictions
References	Dodd, D.E., Longo, L.C. and Eisler, D.L. 1982. Ninety-day vapor inhalation study on rats and mice. Report #44-520. Bushy Run Research Center, Export, PA, for Exxon Corp. East Millstone, NJ Gad, S.C., Snellings, W.M., Egan, G.F., Nachreiner, D.J., Evancheck, R.E. and Dickey, C.L. 1981. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Doc. #81-MR-R2694. Bushy Run Research Center, Export, PA for Exxon Chemical Corp. Snellings, W.M. 1981. 9-day rat and mouse inhalation study. Report #43-527. Bushy Run Research Center, Export PA for Exxon Corp., Linden, NJ (test article description). Gad, S.C., Egan, G.F., Nachreiner, D.J., and Evancheck, R.E. 1980. Acute and subacute inhalation toxicity of dicyclopentadiene in rats and mice. Abst. #130 from the 19th Annual meeting of the Society of Toxicology
Other Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Developmental Toxicity/Teratogenicity

Test Substance	Dicyclopentadiene (DCPD), CAS #77-73-6, $C_{10}H_{12}$, purity 98%
Remarks	
Method	
Method/guideline followed	Standard method, no guidelines specified
Test type	Developmental toxicity – Range finding study
GLP	Yes
Year	1993
Species	Rat
Strain	Sprague Dawley (VAF), CD(SD)BR
Route of administration	Oral gavage
Concentration levels	0, 50, 200, 300, 400 and 500mg/kg/day in corn oil
Sex	Female; timed pregnancies: 11 rats/group for 50-400mg/kg; 10 rats in 500mg/kg group
Exposure period	Days 6-15 of gestation
Frequency of treatment	Once/day in the morning
Control group and treatment	11 timed pregnant rats; 5ml corn oil/kg/ day
Duration of test	Day 5 - 20 of gestation
Statistical methods	Data analyzed using non-parametric statistical methods to identify dose response trends among treatment groups and differences between control and treatment groups. Kruskal-Wallis one-way analysis of variance used for all parameters except gestation day 5-20 body wts, gravid uterus wt and average fetal wts. Mann-Whitney Wilcoxan U test was used when Kruskal-Wallis was significant ($p<0.05$). Jonckheere's test for k independent samples was used for dose-response trends for gestation day 5 to day 20 body wt data. If no trend was found, Dunn's test was used for differences among dose groups; if a trend was present Shirley's test was applied. Body wt data from non-pregnant rats were not included.
Remarks for Test Conditions.	Sixty-five timed-pregnant rats (approx. 77 days old), received on day 5 of gestation (plug date=day 0 of gestation), were individually housed (room environmental information not presented) and identified by tail tattoo. Animals were assigned to control or one of 5 treatment groups using a stratified randomization method. [Reviewer's note: Actual number of animals/group was not specified but was estimated from subsequent data to be 11 rats each/treatment group 50-400mg/kg and vehicle control, and 10 rats/500mg/kg group.] All animals found dead prior to scheduled necropsies were examined for gavage injury and pregnancy. Non-pregnant animals were excluded from body wt data and all subsequent tabulations. Doses of 50-500mg/kg were selected based on the reported LD_{50} range for DCPD in rats of 378-820mg/kg. Test solutions were formulated in corn oil (w/v) and administered at a standard volume of 5ml/kg body wt. for all dose levels. Dosages were adjusted based on body wt on gestation days 6, 8, 10, 12 and 14. Dosage solutions were analyzed by capillary gas chromatography for concentration accuracy and stability. Corn oil solutions containing 10mg/ml of DCPD were stable when stored for 30 days in sealed glass bottles at room temperature. Body wts were recorded on gestation days 5, 6, 8, 10, 12, 14, 16 and 20 (termination). Clinical signs of toxicity or mortality were evaluated twice daily during and post-dosing. At Caesarean section, the following data were collected: terminal body wt of dams, gravid uterine wt, live litter wt, number of implantation sites, resorptions, dead fetuses and live fetuses.
Results	
NOAEL maternal toxicity	NOAELmaternal was not determined.
NOAEL developmental toxicity	NOAELfetal = 50mg/kg (Assigned by reviewer)
Maternal effects	Signs of systemic toxicity beginning at day 7 of gestation were observed in all animals dosed at 200mg/kg and above. Clinical signs included dried material around nose and mouth, rough hair coat, and lethargy increasing in severity with increasing dose; convulsions (1 rat in 200mg/kg group), hunched posture (6 rats in 300mg/kg group)and ataxia (5 rats in 300mg/kg, 11rats in 400mg/kg and 9 rats in 500mg/kg/day groups). All

	animals in the 400 and 500mg/kg/day groups were found dead by gestation day 9; 3/7 and 8/9 pregnant rats in groups 200 and 300mg/kg/day were found dead or were sacrificed for humane reasons by gestation day 9. Body wts of treated pregnant rats were decreased in a dose-related manner beginning at gestation day 8. Statistically significant differences from vehicle control (9 total rats) were observed on gestation days 8 and 10 in the 50mg/kg/day group (10 rats; 6% lower on both days), gestation days 8-20 in 200mg/kg (4 rats; 16-21% lower during treatment, 9% lower post-treatment) and 300mg/kg (1 rat) groups, and gestation day 8 in the 400 and 500mg/kg groups (all animals died on day 9). Dose-related decreases were also noted for body wt gain: statistically significant decreases during treatment (25 and 60% less than controls, respectively) in the 50 and 200mg/kg groups, wt gain during gestation (20% less) and corrected wt gain (23% less) were significantly decreased in the 200mg/kg group. The single pregnant female in the 300mg/kg/day group was excluded from wt gain calculations.
Embryo/fetal effects	At the gestation day 20-caesarean section, average fetal wt was significantly lower by 10% compared to controls in the 200mg/kg group; the single rat in the 300mg/kg group resorbed her litter. All other fetal parameters, including live fetuses/litter, dead fetuses/litter, resorptions/litter, completely resorbed litter, dead implants/litter and total implants/litter in the 50 and 200mg/kg/day dose groups did not differ from vehicle controls.
Conclusions (study authors)	In this range-finding study, dicyclopentadiene treatment caused maternal toxicity and lethality at doses of 200mg/kg/day and above with 100% mortality of animals treated at 400 and 500mg/kg/day. Body wt and wt gain were decreased at all dose levels, reductions being greater with increasing doses. The only developmental toxicity in surviving litters was decreased fetal wt. in the 200mg/kg/day group.
Data Quality *Reliabilities*	**2.** Reliable with restrictions. Actual number of animals/group not specified. Room environmental conditions not reported.
References	Gulati, D.K. et al. 1993. Range-finding studies: Developmental toxicity of dicyclopentadiene when administered via gavage to CD Sprague-Dawley rats. Study No. NTP-92-RF/DT-038. Environmental Health Research and Testing, Inc. Lexington, KY. for National Toxicology Program, NIEHS, Research Triangle Park, NC
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Developmental Toxicity/Teratogenicity

Test Substance	Dicyclopentadiene (DCPD), CAS #77-73-6, C10H12, purity 98%
Remarks	
Method	
Method/guideline followed	Standard method, no guidelines specified
Test type	Developmental toxicity – Range finding study
GLP	Yes
Year	1993
Species	Rabbits
Strain	New Zealand White
Route of administration	Oral gavage
Concentration levels	0, 25, 100, 200, 300 and 400mg/kg/day in corn oil
Sex	Female; presumed pregnant: 10/group
Exposure period	Days 6-19 of gestation
Frequency of treatment	Once/day in the morning
Control group and treatment	10 presumed pregnant rabbits; 1ml corn oil/kg/ day
Duration of test	Day 2 - 30 of gestation
Statistical methods	Data analyzed using non-parametric statistical methods to identify dose response trends among treatment groups and differences between control and treatment groups. Kruskal-Wallis one-way analysis of variance used for all parameters except gestation day 3--30 body wts, gravid uterus wt and average fetal wts. Mann-Whitney Wilcoxan U test was used when Kruskal-Wallis was significant ($p<0.05$). Jonckheere's test for k independent samples was used for dose-response trends for gestation day 3 to day 30 body wt data. If no trend was found, Dunn's test was used for differences among dose groups; if a trend was present Shirley's test was applied. Body wt data collected after animals aborted were not included.
Remarks for Test Conditions.	Sixty presumed-pregnant rabbits (approx. 22 wks old), received on day 2 of gestation (breeding date=day 0 of gestation), were individually housed (room environmental information not presented) and identified by ear tattoo. Animals were assigned to control or one of 5 treatment groups using a stratified randomization method. Doses of 25-400mg/kg were selected based on the reported LD_{50} range for DCPD in rats of 820mg/kg, as no rabbit data were available. Test solutions were formulated in corn oil (w/v) and administered at a standard volume of 1ml/kg body wt. for all dose levels. Dosages were adjusted based on body wt on gestation days 6, 8, 10, 12, 14, 16 and 18. Dosage solutions were analyzed by capillary gas chromatography for concentration accuracy and stability. Corn oil solutions containing 10mg/ml of DCPD were stable when stored for 30 days in sealed glass bottles at room temperature. Body wts were recorded on gestation days 3, 6, 8, 10, 12, 14, 16 18, 20, 25 and 30 (termination). Clinical signs of toxicity or mortality were evaluated twice daily during and post-dosing. At Caesarean section, the following data were collected: terminal body wt of dams, gravid uterine wt, number of implantation sites, resorptions, dead fetuses and live fetuses.
Results	
NOAEL maternal toxicity	NOAELmaternal =25mg/kg. (based on abortion by 1 dam at 100mg/kg/day)
NOAEL developmental toxicity	NOAELfetal = 300mg/kg (Assigned by reviewer)
Maternal effects	Signs of systemic toxicity (decreased food and water consumption) were noted in all animals in the 300 and 400mg/kg/day groups beginning on gestation day 9; 1/9 and 3/9 rabbits in the 300 and 400mg/kg groups, respectively, died prior to scheduled necropsy. In the 100mg/kg/day group, one rabbit aborted her litter beginning on gestation day 18; another had bloody vaginal discharge beginning on day 26 of gestation but was pregnant at scheduled necropsy. In the 300mg/kg group, 1 rabbit had a bloody vaginal discharge beginning on day 19 of gestation, aborted 4 kits on day 21 with an additional 9 masses on gestational day 22. Three animals in the 400mg/kg/day group had blood vaginal discharges; 2 recovered over several days, one was dead on gestation day 23. Body wts

Embryo/fetal effects	taken after abortions and developmental toxicity data from the 2 animals that aborted were not included in data analysis. Maternal body wt decreased in a generally dose-related manner beginning on gestation day 8, becoming statistically significant ($p<0.05$) from controls from day 10 through gestation day 18 for the 300mg/kg group and day 8-30 for the 400mg/kg group. Maternal wt gain during treatment was also statistically significantly decreased compared to controls in the 200mg/kg/day and higher groups. At Caesarean section, the number of resorptions and non-live implants/litter were higher, and the number of fetuses was lower, in the 400mg/kg group compared to controls but were not statistically significant. Two litters from this group showed gross deformities of kits – one with eyes open and 1 with eyes open and deformed hind limbs in one litter of 3 total live kits, and eyes open in all 12 kits from another 400mg/kg litter. No other developmental parameters were adversely affected.
Conclusions (study authors)	Dicyclopentadiene caused maternal toxicity at 200mg/kg/day and higher dose levels and abortion of 1 litter at 100mg/kg in this range-finding study. Gross deformities were evident in two litters from dams given 400mg/kg/day but no other developmental endpoints were significantly affected at any other maternally toxic or non-toxic dose level.
Data Quality *Reliabilities*	**1.** Reliable without restrictions.
References	Gulati, D.K. et al. 1993. Range-finding studies: Developmental toxicity of dicyclopentadiene when administered via gavage to New Zealand White rabbits. Study No. NTP-92-RF/DT-044. Environmental Health Research and Testing, Inc. Lexington, KY. for National Toxicology Program, NIEHS, Research Triangle Park, NC
Other L*ast changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Developmental Toxicity/Teratogenicity

Test Substance	Dicyclopentadiene (DCPD) CAS #77-73-6, purified
Remarks	
Method	
Method/guideline followed	Standard method, no guideline specified
Test type	Teratogenesis
GLP	Not specified
Year	1978
Species	Rat
Strain	Sprague Dawley [CRL:COBS CD(SD)BR]
Route of administration	Diet (Purina Laboratory Meal Chow)
Concentration levels	0, 80, 250, 750ppm
Sex	Female, pregnant (20/treatment group)
Exposure period	Days 6-15 of gestation
Frequency of treatment	Ad lib exposure to treated diet
Control group and treatment	21 pregnant females; diet containing 300ml corn oil/10kg meal
Duration of test	Day 0-19 of gestation
Statistical methods	Dunnett's t-test used for body wts and food consumption of dams, mean pup wts based on litter averages. ($p<0.05$). Ratios (e.g. sex, pregnancy) analyzed by 2x2 contingency table with Yates' correction. Discontinuous parameters (e.g. number of abnormal fetuses in a litter) were evaluated by Wilcoxon Rank Sum. The litter was the basic sampling unit.
Remarks for Test Conditions.	Female rats were acclimated for 12 days then paired with sexually mature males (1:1) of the same strain and supplier. Females were examined daily for evidence of mating and the presence of a copulatory plug was considered day 0 of gestation. Mated female rats, approximately 11 wks old at time of first dose (day 6 of gestation) were assigned sequentially to treatment groups and identified by cage cards. Females were individually housed in wire cages in a temperature-controlled room (Temp. and humidity ranges not reported) with a 12hr light/dark cycle. Appropriate diets and fresh water (acidified pH 2.5) were provided ad lib. DCPD was incorporated in basal diet daily on days 6-15 of gestation. Test material (0.8, 2.5, and 7.5g) was suspended in 300ml corn oil and blended with 10kg basal diet in a twin shell blender for 15 min. Vehicle control diet contained 300ml corn oil in 10kg meal. Mated females were weighed on day 0, 6, 16 and 19 of gestation. Food consumption was measured during period 0-6, 6-16 and 16-19 of gestation. Animals were observed daily for changes in general appearance, behavior and condition. On day 19 of gestation, adult females were sacrified by chloroform anesthesia, visceral and thoracic regions were examined, and the uterus removed and opened. Number of implantation sites, placement in uterine horns, live and dead fetuses, and resorption sites were recorded. Fetuses were removed, examined extemally for abnormalities and weighed. One third of fetuses from each litter were fixed in Bouin's fluid for soft tissue examination of head, thoracic and visceral organs. Remaining fetuses were eviscerated and stained with Alizarin Red S for skeletal examination. Uterus and ovaries of adult females were preserved in 10% formalin.
Results	
NOAEL maternal toxicity	NOAELmaternal and embryo/fetal toxicity = 750ppm. Assigned by reviewer.
NOAEL developmental toxicity	
Maternal effects	No adult females died during the study and all appeared normal on day 19 of gestation, except for 1 rat in the 80ppm group that was emaciated, had an arched back and red crust around the mouth and nose. Mean body wts and food consumption indicated no significant differences between control and treated pregnant rats (Data cited in Appendix 1, not included with report). Test material did not produce any adverse effects on uterine contents on day 19 of gestation. Pregnancy ratios were: 19/21, 20/20, 19/20 and 19/20 in 0, 80, 250 and 750ppm groups, respectively. All dams in all groups had live litters.
Embryo/fetal effects	Incidence of litters with resorptions was 74%, 40%, 58% and 42%; live fetuses/implantation site was 94%, 93%, 93% and 96% and mean live litter size was 15.5,

	13.9, 14.4 and 14.7pups/litter in 0, 80, 250 and 750ppm groups, respectively. There were no litters with dead fetuses. Average fetal wt and length (combined sexes), and sex ratio were comparable to controls. Examination of offspring at delivery revealed subcutaneous hematomas in some fetuses from litters at all groups including controls. In the control group, one fetus had swelling of the right hind limb, and one fetus from a different control litter had intestines protruding from the umbilicus. Bouin's fixed specimens revealed only the absence of left kidney in one control fetus, enlarged kidney in one 80ppm fetus, and unilateral anophthalmia in one 750ppm fetus; no other soft tissue effects were seen. Results of skeletal examination demonstrated commonly encountered changes in all dose groups. A few instances of retarded bone ossification were observed in 2, 3, 0 and 2 litters in control, 80, 250 and 750ppm groups, respectively but variation and incidences were within historical range for the laboratory and did not indicate adverse effect on fetal growth and development, or teratogenic potential.
Conclusions (study authors)	Administration of dicyclopentadiene to female rats from day 6-15 of gestation by incorporation in the diet at 80, 250 and 750ppm produced no adverse effect on pregnant dams and did not induce terata, variations in fetal sex ratio, embryotoxicity or inhibition of fetal growth and development.
Data Quality *Reliabilities*	**2.** Reliable with restrictions. Analysis of test material in diet was not performed. Although diet was prepared daily, accuracy of blending was not verified. Food consumption data was not presented and actual volume of test material ingested/group was not calculated. Adherence to GLP was not indicated.
References	Beliles, R.P. 1978. Teratology study in rats using dicyclopentadiene in diet. LBI Proj. #10734-05. Litton Bionetics, Inc., Kensington, MD, for US Army Medical Bioengineering Research and Development Command, Washington, DC Contract No. DAMD17-77-C-7003 (1980)
Other L*ast changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Toxicity to Reproduction

Test Substance	Dicyclopentadiene, CAS # 77-73-6 (3a, 4, 7, 7a-Tetrahydro-4, 7-methanoindene), purity 94.65%.
Remarks	
Method	
Method/guideline followed	OECD Guideline 422:
Test type	Combined repeated dose toxicity study with reproduction/ developmental toxicity screening
GLP	Yes
Year	1998
Species	Rats
Strain	Sprague Dawley (Crj:CD[SD]) from Charles River Japan, Inc
Route of administration	Oral gavage
Duration of test	Males 44 days; Females from 14 days before mating through gestation and parturition until day 3 of lactation
Concentration levels	0, 4, 20, 100mg/kg/day in olive oil
Sex	Males and females; 10M, 10F/group (ages not specified)
Exposure period	Maximum 45 consecutive days
Frequency of treatment	Once/day
Control group and treatment	Males and females; olive oil, once/day
Statistical methods	None specified
Remarks for Test Conditions.	No study details provided. In OECD guideline 422, test substance is administered to male and female rats daily by oral gavage from 2 weeks prior to mating and during mating (approx. 2 weeks). Male rats continue to be dosed for at least another two weeks post-mating or, as in this study, until sacrifice of females after day 3 of lactation. Females continue to be dosed through gestation to day 3 of lactation. Females are sacrificed on day 4 of lactation and males on day 45 of the study.
Results	
NOAEL	NOELrepeat dose toxicity: Males < 4/mg/kg/day; Females = 20mg/kg/day NOELreproduction: Parental Males = 100mg/kg/day; Dams and offspring = 20mg/kg/day Repeat dose toxicity: Two females in the high dose (100mg/kg) group died; males and surviving females showed slight suppression of body wt gain and decreased food consumption. Blood chemistry of high dose males showed increase in GOT and GPT; no test material related changes occurred in hematology parameters for any treatment group. Increased weight of liver and kidneys of male rats given 100mg/kg were accompanied by single cell necrosis in liver, and hyaline droplets and basophilic changes in tubular epithelium of kidneys under microscopic examination. Increase in fatty droplets in fascicular zone of adrenals was observed in both males and females in the 100mg/kg group. Similar histopathologic changes were seen in kidneys of 4, 20mg/kg group male rats and in adrenals of 20mg/kg group male rats. Reproduction/Developmental toxicity: Dicyclopentadiene had no effect on mating, fertility, gestation, implantation, or delivery indices, or on gestation length, number of corpora lutea, implantations, or parturition. Two females in the 100mg/kg group lost 100% of their litters during lactation (days 1-4). [Reviewer's note: It is likely that these are the females that died, but not specified in summary]. A low viability index and tendency to lower birth wt and body wt gain was observed in neonates in the highest dose group (100mg/kg). No significant differences in number of offspring, live offspring at birth, sex ratio or live birth index were found. No abnormal findings were observed in external features, clinical signs in dams or during life of offspring, or at necropsy of offspring.
Conclusions (contractor)	Dicyclopentadiene induced systemic toxicity in male and female rats including death of two females at the 100mg/kg/day dose level. No compound related effects were seen on reproductive parameters although two females in the 100mg/kg group lost 100% litters

	during lactation. Effects on neonates included low viability index, lower birth wt and body wt gain in the 100mg/kg group, but no effects were seen on other parameters in neonates at any dose level.
Data Quality *Reliabilities*	**2.** Reliable with restriction. Limited study design detail; no analytical data on dosing solutions, no numerical or statistical data available. Summary information sheet provided by Japan Chemical Industry Ecology-Toxicology and Information Center (JETOC). Study performed according to OECD Guideline 422 and GLP by a reputable laboratory.
References	JETOC 1998. Special Issue #3; No. 32 (March 1998), Tokyo, Japan. Study performed at Mitsubishi Chemical Safety Institute, Ltd., Kashimagun, Ibaraki, Japan
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Toxicity to Reproduction

Test Substance	Dicyclopentadiene (DCPD) CAS #77-73-6, purified
Remarks	
Method	
Method/guideline followed	Standard method, no guideline specified
Test type	Three generation Reproduction
GLP	Not specified
Year	1979
Species	Rat
Strain	Sprague Dawley [CRL:COBS CD(SD)BR]
Route of administration	Diet (Purina Laboratory Meal Chow)
Duration of test	3 generations (approx. 45-50wks)
Concentration levels	0, 80, and 750ppm nominal concentrations (0, 69.3, 693ppm actual concentrations)
Sex	Males and females (10M, 20F/group in F0 generation)
Exposure period	F0-approx 28 wks; F1a, F2a and F3- in utero, birth to weaning; F1b, F2b- in utero and approx. 31 wks.
Frequency of treatment	Ad lib exposure to treated diet
Control group and treatment	10M, 20F/group in F0 generation; diet containing 300ml corn oil/10kg meal
Statistical methods	No methods specified
Remarks for Test Conditions.	Weanling albino rats were acclimated for 11 days, then assigned randomly to three groups. These F0 generation rats were identified by ear tag and cage cards, housed individually in shoe-box cages on AB-SORB-DRI bedding, except when mating. Food and water were provided ad lib. Room temperature, humidity and light/dark cycle intervals were not specified. Fresh diets were prepared weekly of appropriate quantity of DCPD dissolved in 300ml corn oil, added to 10kg diet and mixed for at least 15min in a twin shell blender. Control diet was prepared in the same way of 300ml corn oil/10kg diet. Dietary batches were analyzed by gas-liquid chromatography. Seven weeks after initiation of treated diet, F0rats were mated, 1 male: 2 females, within a dose group for 2 wks. At the end of 2 weeks, rats were returned to individual cages and females were allowed to deliver. One week after weaning the first litter (F1a), F0 parents were re-mated- each male with 2 different females within the group. One week after weaning the second litter (F1b), F0 parents were killed and gross necropsies were performed. F1b pups (1M, 2F) from each litter, where possible, were selected to be parents for the next generation, and were caged, fed and watered just as the F0 rats. When F1b rats were approx. 100 days old, they were mated to produce the F2a litters and subsequently the F2b litters. Selected F2b pups were used to produce F3 litters. For each litter, observations included gross abnormalities of pups, mean body wt by sex at birth, number of pups/sex at day 4 of lactation, number of pups/sex and body wts at day 21 of lactation (weaning). At day 4 of lactation, each litter was reduced to 8 pups (4/sex if possible). At weaning, gross necropsies were performed on approx. 1/3 of the first litter (a) from all three generations and on 1/3 of F3b litters.
Results	
NOAEL	NOAEL parental and offspring =750ppm (693ppm actual) [all generations]. Assigned by reviewer
General information	Weekly feed analyses showed a 69.3ppm (87%) average value for 80ppm diet level and 693ppm (92%) for the 750ppm level. Body wt and food consumption data were cited in appendices that were not included in this report.
First generation	F0 parents, F1a and F1b offspring: One F0 female in the 80ppm group was found dead in wk. 28; all other F0 rats survived in good condition. Body wt and food consumption were comparable to controls at each interval. Necropsy findings of F0 parents were unremarkable. Reproductive data for F1a mating indicated 100% fertility for males in control and 80ppm groups and 90% in the 750ppm group. All females mated; Fertility index(F1a litters produced/mated F0 females) was 95%, 90% and 80% in 0, 80 and 750ppm groups, respectively. Gestation index (live litter/pregnant females) was 100% and newborn

	viability was 99% for F1a litters in all groups. Number of live pups/litter was 11, 12, and 12 in 0, 80 and 750ppm; pup sex ratio on day 0 of lactation and pup body wt at day 0 and day 21 of lactation were comparable in all groups. F1a pup viability on day 4 of lactation was 98%, 99% and 98% in 0, 80 and 750ppm groups, and at end of lactation (day 21/day 4 after litters reduced to 8 pups) was 100% in all groups. In F1a litters, one pup in an 80ppm litter had a opaque left eye and 1 pup in a 750ppm litter had a crooked tail. In the 2nd mating of F0 parents to produce litters F1b, male fertility was 100%; female fertility was 90% in control and 80ppm groups and 95% in 750ppm group. Gestation index was 100% in all groups. F1b newborn viability was 99%, 97% and 99%, pup viability on day 4 of lactation was 97%, 95% and 94%, and viability on day 21 (weaning) was 97%, 97% and 96% in 0, 80 and 750ppm groups, respectively. Live pups/litter, sex ratio and pup body wt at day 0 and day 21 of lactation were comparable to controls and to F1a data. One pup in an 80ppm litter had a deformed hind foot.
Second generation	F1b parents, F2a and F2b offspring: Body wt of F1b parent rats were comparable or greater than controls except for 80ppm females at wk 20 (just prior to 2nd mating) when a slightly lower mean body wt (not statistically significant) was seen. Food consumption was also comparable except during wk 20 when both males and females in the 750ppm group had statistically significant reduced food intake ($p<0.05$, Students t-test). At necropsy, no gross lesions were found in F1b parents. Male fertility was 100%, 100% and 90% for F2a and F2b mating in 0, 80 and 750ppm groups; female fertility was 95%, 90% and 70% in F2a and 95%, 95% and 85% in F2b mating. Reduction in female fertility at 750ppm was not statistically significantly (chi square) different from the 95% control values and may be attributable to failure of one 750ppm male to sire a litter in either mating, resulting in 2/6 and 2/3 non-productive females in F2a and F2b mating, respectively. Gestation index was 100% for all groups in both matings. Newborn viability indices were 100%, 97% and 100% in F2a litters and 99%, 100% and 98% in F2b litters for 0, 80 and 750ppm groups. Pup viability on day 4 of lactation for F2a litters was 98%, 94% and 98%, and at day 21 after reduction (weaning) was 98%, 97% and 98%; for F2b litters, viability at day 4 was 95%, 98% and 93% and at day 21 was 99%, 98% and 99% for 0, 80 and 750ppm groups, respectively. Live pups/litter were 13, 14; 12, 15 and 12, 14 in litters F2a and F2b in 0, 80 and 750ppm groups, respectively. Sex ratios and pup wts on day 0 and day 21 of lactation were comparable to controls and between F2a and F2b mating for both dose groups, and similar to F1 data. One male pup in 80ppm group had hydrocephalus.
Third generation	F2b parents, F3a and F3b offspring: Body wt and food consumption of F2b parent rats were comparable to controls. Necropsy findings were unremarkable. Male fertility indices were 90%, 100% and 89% in the F3a mating and 90%, 100% and 100% in F3b mating for 0, 80 and 750ppm groups. Female fertility was lower than previous generations in all groups: F3a 65%, 80% and 85%; F3b 85%, 80% and 83% for 0, 80 and 750ppm groups, respectively. Gestation indices were 100% and newborn viability was 99% in F3a litters and 97-98% in F3b litters for all groups. Pup viability at day 4 of lactation was 96% and 98%; 96% and 100%; 99% and 98% in lF3a and F3b litters and at day 21 was 92% and 99%; 100% and 99%; 98% and 97% in F3a and F3b litters for 0, 80 and 750ppm groups, respectively. Live pups/litter ranged from 12-14 in both F3a and F3b mating and were comparable in all groups and with previous generations. Sex ratios were also comparable. A slight reduction in mean pup wt at day 21 (weaning) compared to controls was seen in both treated groups in the F3b litters, only the 750ppm female mean pup wt value was statistically significant. The 80ppm female mean pup wt value was the same but not statistically significant probably due to a slightly larger standard deviation. F3b mean pup wt at day 21 of lactation were: males 49±10g, 44±11g and 43±11g; females 48±9.3g, 41±12g and 41±9.5g for 0, 80 and 750ppm groups, respectively. F3a mean pups wt at day 21, ranged from 46-48g for males and 42-45g for females in all groups. Since mean weanling pup wts in other generations and in the F3a mating were not appreciably different within generations, this F3b occurrence was not considered biologically significant. Pup general observations and necropsy data were unremarkable.
Conclusions (contractor)	Dietary administration of dicyclopentadiene at nominal concentrations of 80 and 750ppm to three successive generations of male and female albino rats had no deleterious effects on reproductive performance or general condition of the animals compared to concurrent controls. No evidence of dose-related teratogenic effects was seen in pups of any generation.

Data Quality	
Reliabilities	**2.** Reliability with restrictions. Actual body wt, food consumption data and details of necropsy of adults not included in the report. Adult organs were not reported to have been weighed or examined h istopathologically. Actual volume of test material ingested in diet/group was not calculated. Adherence to GLP was not indicated.
References	Johnston, C.D. and Belilies, R.P. 1979. Three generation reproduction study in rats using dicyclopentadiene. LBI Proj. #10734-07. Litton Bionetics, Inc. Kensington, MD, for U.S. Army Medical Research and Development Command, Washington, DC Contract No. DAMD17-77-C-7003 (1980)
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary – Group 7: Resin Oils

Invertebrate Acute Toxicity

Test Substance	Dicyclopentadiene, CAS# 77-73-6 (95% purity)
Method	
Method/guideline followed	U.S. EPA, Methods for Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians
Year (guideline)	1975
Type (test type)	Acute toxicity
GLP	Unknown
Year (study performed)	Unknown
Species	Water Flea (*Daphnia magna*)
Analytical Monitoring	Unknown
Exposure Period	48 hours
Statistical Methods	Probit and least squares regression analysis
Test Conditions	
Note: Concentration prep., vessel type, volume, replication, water quality parameters, environmental conditions, supplier of organisms, age, size, weight, loading	Test organisms were obtained from Bionomics Aquatic Toxicology Laboratory and were they were cultured in static, aerated well water with a hardness of 35 mg/L as CaCO3, pH of 7.1, temperature of 21=/-1C, and dissolved oxygen concentration of greater than 60% saturation. Testing was conducted in 250 ml beakers, which contained 166 ml of treatment solution. Diluent water used was aged for at least 24 hours prior to test initiation. For each treatment level, the appropriate amount of test compound was pipetted into 500 ml of diluent water and mixed with a magnetic stirrer. This solution was then divided into three equal aliquots in triplicate beakers to provide replicate exposure treatments. All beakers were maintained at 20=/-1C and test solutions were not aerated during the test. Five organisms were randomly assigned to each test vessel within 30 minutes after the test compound was added and in control vessels resulting in a total of 15 test organisms per treatment level and control.
Results	
Units/Value: Note: Deviations from protocol or guideline, analytical method, biological observations, control survival	24-hour LL50 = 11.6 mg/L (95% confidence limits = 9.2-14.2 mg/L) based on nominal loadings 48-hour LL50 = 10.5 mg/L (95% confidence limits = 8.4-13.2 mg/L) based on nominal loadings
Conclusions (study author)	
Data Quality	
Reliabilities	**(2)** Reliable with restrictions There is less raw data and information on the testing procedure than is desirable in order to rate this study for reliability at a level higher than 2 (reliable with restrictions). There is sufficient information in the report to suggest that the testing procedure followed an acceptable test guideline (U.S. EPA, 1975).
Reference	Bentley, R.E., G.A. LeBlanc, T.A. Hollister, and B.H. Sleight. 1976. Acute Toxicity of Diisopropylmethyl Phosphonate and Dicyclopentadiene to Aquatic Organisms. Gov. Rep. Announc. NTIS Report #AD-AO 37750. (original report from EG&G Bionomics, Wareham, MS, USA)
Other	
Last changed	Revised December 12, 2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary – Group 7: Resin Oils

Fish Acute Toxicity

Test Substance	Dicyclopentadiene, CAS# 77-73-6
Method	
Method/guideline followed	Japanese Industrial Standard, JIS K 0102-1986-71
Year (guideline)	1986
Type (test type)	Acute toxicity
GLP	Unknown
Year (study performed)	Unknown
Species	Orange-Red Killifish (*Oryzias latipes*)
Analytical Monitoring	Unknown
Exposure Period	48 hours
Statistical Methods	Doudoroff or Probit method
Test Conditions	
Note: Concentration prep., vessel type, volume, replication, water quality parameters, environmental conditions, supplier of organisms, age, size, weight, loading	Organisms were supplied by Nakashima Fish Farm (Kumamoto, Japan). Fish were acclimated prior to test initiation in flow through systems using lab water at a temperature of 25+/- 2C for approximately 28 days. Test organisms used in the study were from one lot. Ground water from the testing lab, Kurme Research Laboratories, was used in the study. Water temperature, pH, and dissolved oxygen were continuously monitored in the lab. Total hardness, evaporated residue, chemical oxygen demand, chloride ion, ammonia nitrogen, selected organic substances, and selected heavy metals are periodically measured in water samples to ensure water quality standards are met. Test systems were glass vessels containing 4 L of treatment solution at 25+/- 2C with 10 fish per treatment level and the control. The exposure system used either a static or semistatic procedure with renewal of treatment solution every 8 to 16 hours.
Results	
Units/Value:	48-hour LC50 = 3.7 mg/L
Note: Deviations from protocol or guideline, analytical method, biological observations, control survival	
Conclusions	
(study author)	
Data Quality	
Reliabilities	**(2)** Reliable with restrictions There is less raw data and information on the testing procedure than is desirable in order to rate this study for reliability at a level higher than 2 (reliable with restrictions). There is sufficient information in the report to suggest that the testing procedure followed an acceptable test guideline, JIS K 0102-1986-71. It is unknown if the data represent measured values.
Reference	Chemicals Inspection and Testing Institute, Japan. 1992. Biodegradation and Bioaccumulation Data of Existing Chemicals Based on the CSCL Japan. Japan Chemical Industry Ecology-Toxicology and Information Center. ISBN 4-89074-101-1.
Other	
Last changed	Revised December 12, 2001 (Prepared by a contract to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Methylcyclopentadiene – dimer (MCPD-d). MRD78-91. Analytic characterization, stability and purity refer to Project report #44-521
Method	
Method/guideline followed	None specified.
Type (test type)	Acute
GLP	Not specified
Year	1978
Species/Strain	Rat, Wistar
Sex	Male
No. of animals per sex/dose	5
Vehicle	None
Route of administration	Oral gavage
Test Conditions	Male Wistar rats, at least 8 wks old (255-281g) were individually housed in elevated wire mesh cages in a temperature-controlled room reserved for rats. AAALAC standards were adhered to. Purina rat chow and water were available ad lib, except for the 16-20 hrs prior to dosing. Test material was delivered by gavage to 5 rats, at a dose of 10.0g/kg body wt. as calculated from the specific gravity. Rats were observed for clinical signs 1, 2, 4, and 6 hrs after dosing and once daily thereafter for 14 days. Mortality, toxicity and pharmacological effects were recorded for each rat. These included: piloerection, ptosis, lethargy, chromodacryorrhea, emaciation and diarrhea. Body wt was recorded at initiation and termination. All rats were examined for gross pathology.
Results	
LD_{50} with confidence limits.	The LD_{50} was not reached at 10g/kg. One rat died on day 4. Significant toxic signs were lethargy, ptosis, ataxia and diarrhea, which cleared by day 7. Rats gained weight normally over the 14-day period.
Remarks	
Conclusions (study author)	The LD_{50} was not reached at 10g/kg.
Data Quality	
Reliability	**2.** Reliable with restrictions. Not known whether GLP were applied to this study.
References	Cerven, D.R. 1978. Single oral dose toxicity in rats. Project #MB78-3290. MB Research Laboratories, Inc. Spinnerstown, PA., for Exxon Corp. Dodd, D.E., Fait, D.W. and Eisler, D.L. 1981. Four-hour acute LC50 inhalation study in rats and mice. Proj. Rpt. #44-521. Bushy Run Research Center, Export, PA for Exxon Corp., East Millstone, NJ.
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Methylcyclopentadiene – dimer (MCPD-d), MRD78-91. Analytic characterization, stability and purity refer to Project report #44-521.
Method	
Method/guideline followed	None specified.
Type (test type)	Acute limit test
GLP	Not specified
Year	1978
Species/Strain	Rabbit, New Zealand White
Sex	Not specified
No. of animals per sex/dose	4
Vehicle	None
Route of administration	Dermal
Test Conditions	New Zealand White rabbits, at least 8 wks old (2.0-2.7kg) were individually housed in elevated wire mesh cages in a temperature controlled room reserved exclusively for rabbits on acute tests. Cages and rooms were kept in accordance with AAALAC standards. Rabbit chow and water were freely available. Immediately prior to dosing, the abdomens of 4 rabbits were clipped (200m^2; approx. 10% of body surface) and abraded deep enough to penetrate the stratum corneum, but not deep enough to produce bleeding. Test material was applied dermally to each site at a dose of 3.16g/kg. The area was covered with gauze and secured by 2mil thick plastic dams. After 24 hr of exposure, dams were removed, and the site was wiped free of test article. Signs of dermal irritation were recorded and evaluated at 24hrs, 3, 7, 10, and 14 days. Rabbits were observed for mortality and toxic effects at 2 and 4 hrs post dose and once daily for 14 days. Body wt was recorded pre-test and at termination. Necropsies were performed on all rabbits.
Results	
LD_{50} with confidence limits.	LD_{50} was not reached at 3.16g/kg
Remarks	No mortality was observed. All rabbits exhibited signs of lethargy and ataxia, 3 rabbits had tachypnea, and 2 rabbits had visible, dilated conjunctival blood vessels during the first 4 hr of exposure, which cleared after the first day. Skin reactions were severe and worsened over time until day 10, with signs of recovery by day 14. All rabbits showed severe erythema and skin flaking with 3 rabbits showing scar formation and skin cracking. Upon removal of the binding, rabbits showed moderate skin edema (raised approx. 1mm) that resolved progressively over time. At day 14, there was barely perceptible edema. Approx. 65-70% of the applied dose remained at the application site. At necropsy, one rabbit showed dark areas on the lungs and mottled kidneys.
Conclusions	
(study author)	LD_{50} was not reached at 3.16g/kg
Data Quality	
Reliability	**2.** Reliable with restrictions. Not known whether GLPs were applied to this study.
References	Cerven, D.R. 1978. Acute dermal toxicity in albino rabbits. Project #MB78-3290. MB Research Laboratories, Inc. Spinnerstown, PA. for Exxon Corp. Dodd, D.E., Fait, D.W. and Eisler, D.L. 1981. Four-hour acute LC50 inhalation study in rats and mice. Proj. Rpt. #44-521. Bushy Run Research Center, Export, PA for Exxon Corp., East Millstone, NJ.
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Methylcyclopentadiene dimer (MCPD-d), CAS #26472-00-4. 92% dimer. Liquid of pungent odor. Compositionally stable for at least one month
Method	
Method/guideline followed	None specified.
Type (test type)	Acute Limit test
GLP	Yes
Year	1980
Species/Strain	Rats, Fischer 344
Sex	Males and females
No. of animals per sex/dose	6
Vehicle	Filtered air
Route of administration	Whole Body Inhalation (4hr exposure)
Test Conditions	Rats (5wk. old; males 173g; females 127g) were housed in stainless steel wire mesh cages (3/sex/cage) except during exposure (2/sex/cage). Temperatures were between 68-74^{0}F, with relative humidity between 35-57% and a 12 hr light-dark cycle. Powdered food and water were available ad lib except during exposure. Liquid MCPD-d was heated in a glass evaporator at the lowest temperature sufficient to produce a vapor of 495ppm. Chamber concentration of the test article was monitored by gas chromatography flame ionization detection. One group of 6 male and 6 female rats were exposed once for 4 hrs on day 1 and sacrificed on day 15. Rats were examined during exposure and daily for 14 days. Body wt was recorded at initiation and on days 2, 6, 9 and 15. All rats were necropsied for gross lesions. No tissues were saved for microscopic evaluation
Results	
LC_{50} with confidence limits.	LC_{50} was not reached at 495ppm.
Remarks	No adverse effects were observed in any rats during exposure to 495ppm MCPD-d or post-exposure over the 14-day observation period, and no gross lesions were observed. There was no change in body wt attributable to exposure and body wt increases were within normal limits.
Conclusions (study author)	None of the rats died during the exposure period or within the 14-day observation period. No adverse effects attributable to test article were observed.
Data Quality	
Reliability	**1.** Reliable without restriction.
References	Zelenak, J.P. 1980. Methylcyclopentadiene dimer: Four-hour acute LC_{50} inhalation study on rats and mice. Proj. Rpt. #43-536. Bushy Run Research Center, Pittsburgh, PA for Exxon Corp. Linden, NJ
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Methylcyclopentadiene dimer (MCPD-d), CAS #26472-00-4. 92% dimer. Liquid of pungent odor. Compositionally stable for at least one month
Method	
Method/guideline followed	None specified.
Type (test type)	Acute Limit test
GLP	Yes
Year	1980
Species/Strain	Mice, B6C3F1
Sex	Males and females
No. of animals per sex/dose	6
Vehicle	Filtered air
Route of administration	Whole Body Inhalation (4hr exposure)
Test Conditions	Mice (5wk. old; males 24g; females 19g) were housed in stainless steel wire mesh cages (3/sex/cage) except during exposure (2/sex/cage). Temperatures were between 68-74^{0}F, with relative humidity between 35-57% and a 12 hr light-dark cycle. Powdered food and water were available ad lib except during exposure. Liquid MCPD-d was heated in a glass evaporator at the lowest temperature sufficient to produce a vapor of 495ppm. Chamber concentration of the test article was monitored by gas chromatography flame ionization detection. One group of 6 male and 6 female mice were exposed once for 4 hrs on day 1 and sacrificed on day 15. Mice were examined during exposure and daily for 14 days. Body wt was recorded at initiation and on days 2, 6, 9 and 15. All mice were necropsied for gross lesions. No tissues were saved for microscopic evaluation
Results	
LC_{50} with confidence limits.	LC_{50} was not reached at 495ppm.
Remarks	No adverse effects were observed in any mice during exposure to 495ppm MCPD-d or post-exposure over the 14-day observation period, and no gross lesions were found. There was no change in body wt attributable to exposure, and body wt increases were within normal limits.
Conclusions (study author)	None of the mice died during the exposure period or within the 14-day observation period. No adverse effects attributable to test article were observed.
Data Quality	
Reliability	**1.** Reliable without restriction.
References	Zelenak, J.P. 1980. Methylcyclopentadiene dimer: Four-hour acute LC_{50} inhalation study on rats and mice. Proj. Rpt. #43-536. Bushy Run Research Center, Pittsburgh, PA for Exxon Corp. Linden, NJ
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Repeated Dose Toxicity

Test Substance	Methylcyclopentadiene dimer. 92% dimer. Analytical characterization provided; refer to
Remarks	Project report #44-521 for stability and purity and conditions under which aerosol formation occurs.
Method	
Method/guideline followed	Not specified
Test type	Subacute
GLP	Yes
Year	1982
Species	Rat
Strain	F344
Route of administration	Whole Body Inhalation
Duration of test	12 days
Doses/concentration levels	0, 5, 50 and 404ppm (actual)
Sex	Male and female (10/sex/group)
Exposure period	6hrs/day
Frequency of treatment	once a day for 9 days (days 1-5, 8-11)
Control group and treatment	10 mice, filtered air, 6hrs/day for 9 days (days 1-5, 8-11).
Post exposure observation period	None
Statistical methods	Bartlett's test, analysis of variance, Duncan's multiple range test, F-test or Student's t-test to compare group vs. control, Cochran t-test when Students t-test was significant.
Test Conditions	Fischer F-344 rats, approx. 70 days old at study initiation, were housed in stainless steel, wire mesh cages at 66-76^{0}F and 43-78% relative humidity. The exposure chamber was maintained at 72-82^{0}F and 37-66% relative humidity and kept on a 12 hr light-dark cycle. Food and water were available ad lib, except during exposure. During exposure, rats were housed 2 per cage. Rats were assigned to 4 test groups (10/sex). The liquid test article was vaporized in a heated, spiral-grooved Pyrex tube and diluted with air prior to entering the exposure chamber. Chamber samples were taken once/hr. and analyzed by gas chromatography/flame ionization detection. Rats were observed prior to, during and following exposure for clinical signs and toxic effects. Body weight was taken prior to exposures on days 1, 2, 5, 8, 9, and prior to sacrifice on day 12. Food consumption was measured prior to initiation and 2-3 times during the study. Urine was collected after for 17hrs. after the fifth and ninth exposures. Hematologic tests were performed on all surviving rats at sacrifice; blood was taken from the orbital sinus. At sacrifice on day 12, liver, lungs, kidneys, gonads, and any gross lesions were saved for possible histological evaluation. Histologic evaluation was performed on livers and kidneys from all rats. Livers, lungs and kidneys of all rats and testes of all males were weighed.
Results	
NOAEL (NOEL)	NOAEL females = 50ppm; males < 5ppm
LOAEL (LOEL)	LOAEL females = 404ppm (based on dec. wt. gain);
	males = 5ppm (based on histopathologic effects).
Remarks	Female rats in the 404ppm group had urogenital wetness and periocular redness that persisted. In the second week of exposure, male rats showed periocular redness. Also during the second week of exposure, rats of both sexes had lacrimation. Rats of both sexes at the 404ppm exposure level, had significant decreases in body wt. Male and female rats at 404ppm had significantly lower food consumption after 8 exposures; females also had decreased consumption after 4 exposures. Urinalysis indicated that males were more seriously affected than females. After 5 exposures, males at all exposure levels, had epithelial cells and cell casts in the urine; however, the effects were not seen in females. Urine specific gravity and osmolality were significantly depressed in males. The number of cells and cell casts in male urine were dose related. There were no exposure related hematological effects observed. Rats of both sexes had significant increases in absolute and relative wts, and relative kidney wt at 404ppm. Males, but not females from the 50ppm

	group had increased absolute liver and kidney wts and relative kidney wts. Gross pathology showed a significant frequency of kidney color changes at 404ppm and 2 males were affected at 50ppm; these effects were not seen in females. Treated male rats also showed an occasional reticular pattern in the liver. Histopathological lesions were seen in the kidneys of male rats at all doses; these were concentrations-related, involving protein accumulation in proximal tubule epithelial cells, and tubular hyperplasia in the cortex. In males at all doses, there was an increase in liver mitotic index; this effect was not seen in females.
Conclusions (study authors)	Male rats were more sensitive than females to test article vapor, exhibiting decreased wt. gain, food consumption, and urine specific gravity, increased urine epithelial cells, cell casts, relative liver, kidney and testes wt. Histopathological lesions were also noted in males, as well as increased mitotic index in the liver. Several of the findings in males were dose-related through the lowest dose. Females showed decreased food consumption, wt. gain, clinical signs and increased kidney wt at 404ppm.
Quality Reliabilities	**1.** Reliable without restrictions.
References	Dodd, D.E. and Longo, L.C. 1982. Methylcyclopentadiene – dimer vapor: Nine-day subchronic rat and mouse inhalation study. Proj. Rpt. 44-519. Bushy Run Research Center, Export, PA for Exxon Corp., East Millstone, NJ Dodd, D.E., Fait, D.W. and Eisler, D.L. 1981. Four-hour acute LC50 inhalation study in rats and mice. Proj. Rpt. #44-521. Bushy Run Research Center, Export, PA for Exxon Corp., East Millstone, NJ.
Other Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Repeated Dose Toxicity

Test Substance	Methylcyclopentadiene dimer. 92% dimer. Analytical characterization provided; refer to
Remarks	Project report #44-521 for stability and purity and conditions under which aerosol formation occurs.
Method	
Method/guideline followed	Not specified
Test type	Subacute
GLP	Yes
Year	1982
Species	Mouse
Strain	B6C3F1
Route of administration	Whole Body Inhalation
Duration of test	12 days
Doses/concentration levels	0, 5, 50 and 404ppm (actual)
Sex	Male and female (10/sex/group)
Exposure period	6hrs/day
Frequency of treatment	once a day for 9 days (days 1-5, 8-11)
Control group and treatment	10 mice, filtered air 6hrs/day for 9 days (days 1-5, 8-11).
Post exposure observation period	None
Statistical methods	Bartlett's test, analysis of variance, Duncan's multiple range test, F-test or Student's t-test to compare group vs. control, Cochran t-test when Students t-test was significant.
Test Conditions	B6C3F1 mice, approx. 70 days old at study initiation were housed in stainless steel, wire mesh cages at 66-76^{0}F and 43-78% relative humidity. The exposure chamber was maintained at 72-82^{0}F and 37-66% relative humidity and kept on a 12 hr light-dark cycle. Food and water were available ad lib, except during exposure. During exposure, mice were housed 2 per cage. The liquid test article was vaporized in a heated, spiral-grooved Pyrex tube and diluted with air prior to entering the exposure chamber. Chamber samples were taken once/hr. and analyzed by gas chromatography/flame ionization detection. Mice were observed prior to, during and following exposure for clinical signs and toxic effects. Body weight was taken prior to exposures on days 1, 2, 5, 8, 9, and prior to sacrifice on day 12. Food consumption was measured prior to initiation and 2-3 times during the study. Hematologic tests were performed on all mice surviving to sacrifice; blood was taken from the orbital sinus. At sacrifice on day 12, liver, lungs, kidneys, gonads, and any gross lesions were saved for possible histological evaluation. Histologic evaluation was performed on livers and kidneys from all mice. Livers, lungs and kidneys of all mice and testes of all males were weighed.
Results	
NOAEL (NOEL)	NOAEL females = 50ppm; males = 5ppm
LOAEL (LOEL)	LOAEL females = 404ppm (based on hematology, liver wt, kidney wt); males = 50ppm (based on hematology, liver wt, liver mitotic figures).
Remarks	One male mouse in the 404ppm group died following the first exposure; no other mice died during the study. Test article-related changes in body wt. gain of females were obscured by a drop in control wt. during the first week, but there appeared to be some weight gain thereafter in the exposed groups. In males, there were no test article body wt. effects at sacrifice, but there was an initial decrease. In females there was a significant increase in food consumption after 4 and 9 exposures (values were not obtained for males). In mice of both sexes, there was a statistically significant decrease in erythrocyte count, hemoglobin concentration and hematocrit for the 404ppm group; the decrease was much smaller in the 50 and 5ppm groups, and only significant for hemoglobin concentrations in the 50ppm males. In females, lymphocyte count was decreased at 404ppm. At 404ppm, both sexes had significant increases in absolute and relative liver wt. Male mice did not show kidney or liver perturbations upon microscopic examination. Male mice of the 404 and 50ppm groups had increased mitotic figures in liver, but females did not. No significant histopathological

	effects were seen in kidneys of female or male mice.
Conclusions (study authors)	Most toxic effects were limited to the 404ppm exposure groups, but male mice of the 50ppm group also had an increase in absolute and relative liver wt and increased liver mitotic rate.
Quality Reliabilities	**1**. Reliable without restrictions.
References	Dodd, D.E. and Longo, L.C. 1982. Methylcyclopentadiene – Dimer vapor: Nine-day subchronic rat and mouse inhalation study. Proj. Rpt. 44-519. Bushy Run Research Center, Export, PA for Exxon Corp., East Millstone, NJ Dodd, D.E., Fait, D.W. and Eisler, D.L. 1981. Four-hour acute LC50 inhalation study in rats and mice. Proj. Rpt. #44-521. Bushy Run Research Center, Export, PA for Exxon Corp., East Millstone, NJ.
Other Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	C9 Resin Oil (L) D-47-94. Yellowish liquid of pungent odor. Composition described; major components: indene 21.2%, vinyl toluene 13.9%, methyl styrene 7.0%, dimethyl styrene 7.9%, methyl indene 3.9%.
Method	
Method/guideline followed	Drugs Directorate Guideline, HPB, Health and Welfare Canada, 1990; OECD Guidelines, Sec. 401 and 420, Paris, France 1981 and 1992
Type (test type)	Acute, Limit test
GLP	Yes
Year	1995
Species/Strain	Rats, Sprague Dawley CD[Crl: CD(SD)BR]
Sex	Males and females
No. of animals per sex/dose	5
Vehicle	None
Route of administration	Oral gavage
Test Conditions	Rats (200-300g) were housed in separate quarters in suspended wire cages, 3-5/cage. The animal room was maintained at 22±2^{0}C and 40-70% relative humidity with 12 hr light-dark cycle. Chow diet and water were available ad lib. Rats were dosed with a single oral dose of 2.0g/kg on day 1 and sacrificed on day 15. Rats were observed daily for 14 days for morbidity, mortality and clinical signs. Rats were weighed at initiation and at sacrifice. Gross necropsies were performed on all rats.
Results	
LD_{50} with confidence limits	LD_{50} was not reached at 2.0g/kg. There were no deaths at the limit dose of 2.0g/kg.
Remarks	Male rats showed signs of apathy, piloerection, dyspnea and passivity that cleared by day 3; female rats showed no abnormal signs. Rats of both sexes gained weight normally over the 14-day study period. There were no organs with gross pathological findings.
Conclusions	
(study author)	The rat oral LD_{50} of C9 resin oil was in excess of 2.0g/kg.
Data Quality	
Reliability	**1.** Reliable without restrictions
References	Pucaj, K. 1995. Acute oral toxicity of C9Resin Oil, (L) D-47-94. Project #97383. Nucrotechnics, Scarborough, Ontario, for Novacor Chemicals, Ltd., Calgary Canada
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	C9 Resin Oil (#D-16-95, and #D-17-95). Yellow oily liquid. Composition described; major components: indene 21.2%, vinyl toluene 13.9%, methyl styrene 7.0%, dimethyl styrene 7.9%, methyl indene 3.9%.
Method	
Method/guideline followed	OECD Guidelines, Proc. 403.
Type (test type)	Acute
GLP	Yes
Year	1995
Species/Strain	Rats, Sprague-Dawley
Sex	Males and females
No. of animals per sex/dose	5; 3 dose levels: 1.03±0.2; 2.07±0.31; 5.01±0.34mg/l (actual)
Vehicle	None
Route of administration	Whole Body Inhalation
Test Conditions	Rats (males 236-300g; females 220-257g) were individually housed in suspended stainless steel cages with mesh bottoms. The facility was maintained at 69-72^{0}F and relative humidity of 45-60% with a 12 hour light-dark cycle. Rats were fed chow diet and received water ad lib. Rats were exposed to aerosols generated by a 0.25" atomizer. Gravimetric samples were collected on a 25mm glass fiber filter (GF/B Whatman), weighed and divided by air flow volume to determine chamber concentration. Particle mass median aerodynamic diameters for the 3 dose levels were 1.9-3.4µm. The exposure period lasted slightly longer than 4 hrs to provide for chamber equilibrium. At the end of the exposure period, rats were removed from the chamber, and returned to holding cages. Body wt. was recorded at initiation day 0, day 7 and day 14. Rats were observed for toxic signs, including mortality and morbidity, every 30 min. during exposure, at removal from chambers and once daily thereafter. Gross necropsies were performed on all rats. LC_{50} ± 95% confidence limits were determined by Probit analysis.
Results	
LC_{50} with confidence limits.	LC_{50}: Males 1.40mg/l (no confidence limits calculated); Females 1.90 (± 0.96-3.75) mg/l: combined sexes 1.65 (±1.18-2.32) mg/l.
Remarks	Following exposure, rats from all dose levels exhibited one or more of the following signs: facial staining, abnormal respiration, abnormal posture, loss of balance, piloerection, hunched posture and/or hypoactivity. All rats at the 5.01mg/l dose died within 3 days following exposure, with 4 rats dying during exposure; these rats showed irregular and shallow breathing, dyspnea and prostration. Gross necropsy showed discoloration of the lungs, liver and gastrointestinal tract. At the 2.07mg/l dose, all males and 2 females died within 3 days of exposure. The 3 surviving females developed loss of balance but all symptoms cleared by day 7, and animals showed normal body wt gain for the duration of the study. Gross necropsy of the rats dying during study showed discoloration of the lungs, but no remarkable findings were seen in rats sacrificed on day 14. At the 1.03mg/l dose, one female rat died within 3 days of exposure. Surviving rats developed loss of balance, gasping, and prostration. The surviving rats recovered by day 5, and gained body wt. normally for the remainder of the study. Gross necropsies done at terminal sacrifice were unremarkable.
Conclusions (study author)	LC_{50}: Males 1.40mg/l (no confidence limits calculated); Females 1.90 (± 0.96-3.75) mg/l: combined sexes 1.65 (±1.18-2.32) mg/l.
Data Quality	
Reliability	**1.** Reliable without restrictions
References	Wnorowski, G. 1995. Acute inhalation toxicity defined LC50, OECD Guideline #403, Study #3718. Product Safety Labs, East Brunswick, NJ, for Novacor Chemicals Ltd., Calgary, Canada
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	C9 Resin Oil (#D-16-95, and #D-17-95). Yellowish liquid of pungent odor. Composition described; major components: indene 21.2%, vinyl toluene 13.9%, methyl styrene 7.0%, dimethyl styrene 7.9%, methyl indene 3.9%.
Method	
Method/guideline followed	Modified Draize method- OECD Guidelines, Sec. 404, Paris 1981 (revised 1992)
Type (test type)	Acute Irritation
GLP	Yes
Year	1995
Species/Strain	Rabbit, New Zealand albino
Sex	Females
No. of animals per sex/dose	3
Vehicle	None
Route of administration	Dermal
Test Conditions	Rabbits were housed in individual stainless steel cages and received rabbit chow and water ad lib. The facility was maintained at 22^0C and 40-70% relative humidity with a 12 hr light-dark cycle. About 24 hrs before dosing, the back of each of three rabbits was closely clipped free of hair and divided into two 3cmx3cm sites with a marker. One site was designated the control and the other, the test site. Each test site was covered with a sterile gauze patch to which 0.5ml of test article was applied and affixed to the rabbit with adhesive tape. The control site was patched but untreated. The entire trunk was wrapped In a rubber dam for a 4 hr exposure period. Control and test article-exposed sites were examined at 1, 24, 48,72, and 96hrs and on days 5, 7, 10, and 14 following exposure period, and scored by the Draize method.
Results	The readings for the first 7 days indicated slight erythema and edema of test article-exposed skin (score 1-2). From days 10-14, there was no irritation, however, there was slight skin desquamation. The primary irritation score was 2.6±0.2.
Remarks	
Conclusions	
(study author)	The test article was concluded to be a mild irritant to the skin.
Data Quality	
Reliability	**1.** Reliable without restrictions
References	Pucaj, K., 1995. Dermal irritation/corrosion test of resin oil, (L) D-47-94, in rabbits. Proj. #97811. Nucrotechnics, Scarborough, Ontario, for Novacor Chemicals, LTD, Calgary, Canada.
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	C9 Resin Oil (L) D-47-94. Yellowish liquid of pungent odor. Composition described; major components: indene 21.2%, vinyl toluene 13.9%, methyl styrene 7.0%, dimethyl styrene 7.9%, methyl indene 3.9%.
Method	
Method/guideline followed	Modified Draize method- OECD Guidelines, Sec. 405, Paris 1992
Type (test type)	Acute Eye Irritation
GLP	Yes
Year	1995
Species/Strain	Rabbit, New Zealand albino
Sex	Not specified
No. of animals per sex/dose	3
Vehicle	None
Route of administration	Lower conjunctival sac of one eye/rabbit
Test Conditions	Rabbits were housed in individual stainless steel cages and received rabbit chow and water ad lib. The facility was maintained at 22^0C and 40-70% relative humidity with a 12hr light-dark cycle. A 0.1ml volume of C9Resin oil was instilled into the lower conjunctival sac of one eye of each of 3 rabbits. The test article stayed in contact with the eye for a 24 hr exposure period. The opposite eye of each rabbit served as a control. Evaluation for irritancy was made at 24, 25, 48, 72, and 96 hrs and on day 5 following exposure. Scoring was by the Draize method.
Results	The cornea and iris were not affected by the test material, but there were conjunctival redness and discharge in treated eye of each of the 3 rabbits. Effects were maximal after 72 hrs and gradually cleared by post-dose day 5. At 72 hr, total scores for redness, chemosis and discharge in the 3 rabbits were 8, 12, and 2 with 2 of the 3 rabbits having individual scores of 2 or higher.
Remarks	
Conclusions (study author)	Because 2 rabbits showed individual Draize scores for redness of 2 and 3, at 72 hr post-dose, C9 Resin oil, (L) D-47-94 was considered to be a strong eye irritant.
Data Quality	
Reliability	**1.** Reliable without restrictions.
References	Pucaj, K., 1995. Acute eye irritation/corrosion test of C9 resin oil, (L) D-47-94, in rabbits. Proj. #97811. Nucrotechnics, Scarborough, Ontario, for Novacor Chemicals, LTD, Calgary, Canada.
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Genetic Toxicity - in Vitro

Test Substance	C9 Resin Oil, CAS # 68477-54-2. Steam cracked C8-C12 fraction naphtha; Lyndell Resin Oil 90. Clear, pale yellow to yellow colored liquid with gasoline-like naphtha odor
Test substance	
Method	
Method/guideline followed	Standard method based on Ames et al, 1975, Maron & Ames, 1983, and Green & Muriel, 1976.
Type	Reverse mutation bacterial assay
System of testing	Salmonella typhimurium and Escherichia coli with and without metabolic activation
GLP	Yes
Year	1994
Species/Strain	S. typhimurium TA97, TA98, TA100, TA102, TA1535, and E. coli WP2 uvrA (pKM101)
Metabolic activation	Yes
Species and cell type	Sprague Dawley male rat liver (S9 fraction) from Molecular Toxicology, Inc. College Park, MD
Quantity	20µl S9 fraction in 0.5ml S9 mix/plate
Induced or not induced	Aroclor 1254-induced, rats were given a single ip 500mg/kg dose, 5 days prior to sacrifice.
Concentrations tested	0, 39, 78, 156, 313, and 625µg/plate –S9, and 0, 78, 156, 313, 625, and 1250µg/plate + S9; samples diluted in dimethyl sulfoxide (DMSO). Negative control 100µl DMSO
Statistical Method	None. Criteria for a positive response were dose related increase in mutant frequency and more than one dose level exhibited a mutant frequency at least 2-fold greater than solvent control. Equivocal response was defined as a 2-fold increase above control level at one or more doses with no evidence of a dose response.
Remarks for Test Conditions	C9 resin oil test solutions were prepared in DMSO immediately prior to use. Salmonella strains and E. coli WP2 (approx. 10^9cells/ml) were exposed to either test solution or DMSO ±S9 in 3 plates/dose/strain by the plate incorporation method. A preliminary toxicity assay using TA97 and TA100 -S9 was performed over 9 doses from 78-20,000µg/plate to establish optimal doses for the mutagenicity assay. In the mutagenicity assay, dose concentrations were 37-625µg/plate –S9, and 78-1250µg/plate +S9. All plates were incubated at 37^0C for 48 hrs, then revertant colonies were counted. Positive control compounds were: -S9, ICR191 (1µg/plate) for TA97, 2-nitroflourene (2-NF, 5µg/plate) for TA98, sodium azide (NaA, 1.5µg/plate) for TA100 and TA1535, mitomycin C (0.5µg/plate) for TA102 and methyl methanesulfonate (MMS, 1000µg/plate) for E. coli WP2; +S9 2-aminofluorene (2-AF, 10µg/plate) for all Salmonella strains and 2-aminoanthacene (2-AA, 5µg/plate) for E. coli WP2. Two independent assays were performed.
Results	
Genotoxic effects	In the preliminary toxicity assay, precipitate was visible at all dose levels (78-2000µg/plate). Number of revertants relative to solvent control was reduced for all doses, with a dose-related decline from =625µg/plate. Background lawn for both TA100 and TA97 showed a marked clearing beginning at 625µg/plate. In the first mutagenicity test without activation, all tester strains showed a progressive decline in revertant colony count with increasing dose (e.g. TA100: 142, 88, 124, 77, 63, and 70 revertants/plate, and E. coli: 246, 256, 262, 247, 218, and 200 at 0 [DMSO], 39, 78, 156, 313, and 625µg/plate, respectively). Clearing of background lawn was observed at 625µg/plate. In the S-9 activated cultures, all strains except TA100, TA1535 and E. coli WP2, showed a dose-related reduction in revertant frequency at all dose levels (e.g. TA97: 287, 290, 269, 247, 219, and 155 at 0, 78, 156, 313, 625, and 1250µg/plate. In TA100, TA1535 and E. coli WP2, the revertant frequency was similar to vehicle controls. No increase in revertant colonies was observed. Clearing of background lawns was observed at 625 and 1250µg/plate for all tester strains. In the independent repeat assay, although little discussion is provided in the text, the data tables demonstrate that toxicity did not appear to be as severe as in the initial assay. No significant reduction in revertants occurred over the range of doses, and there was no increase in revertant frequency above the solvent control in any strain at any dose level ±S9 (e.g. TA100 –S9: 161, 173, 196, 190, 169, 153 at 0, 37, 78, 156, 313, and 625µg/plate;

	+S9: 174, 161, 154, 161, 150, and 119 at 0, 78, 156, 313, 625, and 1250µg/plate, respectively. Positive control compounds performed appropriately: in -S9 cultures: ICR191- 483; 2-NF- 1200; NaA- 1378 for TA100, 867 for TA1535; mitomycin C 800; MMS- 4277 for E. coli; in +S9: cultures: 2-AF 953-3167 for Salmonella strains; 2-AA-2083 for E.coli. C9 resin oil was considered non-mutagenic in this test system. (Reviewer's note: This Salmonella/ E. coli assay is an acceptable, negative mutagenicity test based on the results of the independent repeat assay. Although both assays were performed at the same dose levels ± S9, the toxicity in the first assay, evidenced by a dose-related reduction in revertant colonies and inhibition of background lawn at most doses made it a less reliable predictor of mutagenicity. The second assay had less toxicity at the same dose levels and did not demonstrate any increase in revertants above vehicle control for any dose in any strain tested.)
Conclusions (contractor)	C9 Resin Oil did not induce a significant increase in Salmonella strains or E. coli with or without metabolic activation at any dose level and is not considered a mutagen in this test system.
Data Quality *Reliabilities*	**2.** Reliable with restrictions. Given toxicity seen in the preliminary test, some doses lower than 39 or 78ug/plate should have been employed to provide a better profile of effect.
Reference	Mehta, R.D. 1995. Mutagenicity of C9 Resin Oil in the Salmonella/E. coli assay. Study No. 950315/2. Prairie Biological Research Ltd., Edmonton, Alberta, Canada, for Novacor Chemicals, Ltd., Calgary, Alberta, Canada Ames, B.N. et al. 1975. Mutat. Res. 31: 347-364. Green, M.H.L., and Muriel, W.J. 1976. Mutat. Res. 38: 3-32. Maron, D.M., and Ames, B.N. 1983. Mutat. Res. 113: 173-215.
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Composition analysis, purity and stability referred to sponsor. T-119
Method	
Method/guideline followed	None specified, comparable to standard study
Type (test type)	Acute
GLP	Yes
Year	1983
Species/Strain	Rat, Fischer 344
Sex	Males and females
No. of animals per sex per dose	5
Vehicle	Corn oil
Route of administration	Oral gavage
Test Conditions	Rats (64 days old, 131-222g) were individually housed in metal, screen-bottomed cages and received food and water ad lib. Animal rooms were maintained at 75^0F with relative humidity of 61% and a 12-hour light/dark cycle. Test article was administered, as a suspension in corn oil, to 24 hr fasted animals, at levels of 0.32, 0.56, 1.0, and 1.8 g/kg. Rats were evaluated daily for 14 days following dosing. Observations for morbidity/mortality were performed daily for 14 days. Body wts were taken at initiation, day 8 and day 15. Each rat was observed at 1 and 4 hr post-dosing, and at least once daily thereafter for clinical signs for 14 days. Gross necropsies were performed on all rats. Acute oral LD_{50}s for each sex and combined sexes were determined by Probit analysis. A precise oral LD_{50} could not be obtained in male rats because there was only one data point between 0 and 100% deaths.
Results	
LD_{50} with 95% confidence limits.	Female: 0.97 (0.57-1.96)g/kg; Male: >0.56<1.8g/kg; Combined: 0.96 (0.73-1.26)g/kg. Normal body wt. increases were observed in surviving animals at 7 and 14 days. Clinical signs (other than death) occurred sporadically in all groups. Signs included arching of the back, bloody discharge from nose/mouth, hypersensitivity, backward-moving motor activity, and tremors. All deaths occurred within 48 hrs of dosing. Deaths occurred as follows: 1) Males; 0.32g/kg, 0/5; 0.56g/kg, 0/5; 1.0g/kg, 3/5; 1.8g/kg, 5/5; 2) Females; 0.32g/kg, 0/5; 0.56g/kg, 1/5; 1.0g/kg, 3/5; 1.8g/kg, 4/5. Necropsies of rats dying during the study showed dose-related congestion in abdominal, cranial, and thoracic cavities. At terminal sacrifice, only 2 rats showed congestion (sex and dose group not reported).
Remarks	
Conclusions	
(study author)	LD50 for combined sexes was 0.96 (0.73-1.26)g/kg.
Data Quality	
Reliability	**1.** Reliable without restrictions
References	Rausina, G.A. 1983. Acute oral toxicity study in albino rats using Resin-Former Feedstock. Proj. #2016. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co. Houston, TX
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Composition analysis, purity and stability referred to sponsor.
Method	
Method/guideline followed	None specified, comparable to standard study
Type (test type)	Acute limit test
GLP	Yes
Year	1983
Species/Strain	Rats, Fischer 344
Sex	Males and females
No. of animals per sex per dose	5
Vehicle	Filtered air
Route of administration	Inhalation (whole body)
Test Conditions	Rats (16 wks old, 157-276g) were maintained at 24.6^{0}C with 48% relative humidity and a 12-hour light/dark cycle. One group of 10 rats was exposed to the test article at an actual concentration of 5.4g/m^3, for 4 hrs in a stainless steel, dynamic exposure chamber. A test article aerosol was generated with a ball-jet nebulizer, and chamber concentration was controlled by varying both dilution air and inlet pressure of filtered air. Chambers were sampled with a gas-tight syringe and samples were directly injected directly into a gas chromatograph. Concentrations were determined by comparing peak area of sample with that of standards. Test article was volatile and gravimetric samples could not be taken, so particle size was determined during exposure by laser velocity measurement (MMAD 5.0µm±1.4 SD; 89% of particles <10µm). Body wt. was taken after exposure and on day 7 and 14. Mortality checks were made during exposure and daily thereafter. Clinical signs were noted at 1 and 4 hrs post-exposure, and daily thereafter. Non-fasted rats were sacrificed and necropsied for gross lesions.
Results	
LC_{50} with confidence limits.	Not reached at 5.4g/m^3.
Remarks	There were no deaths during the study. Rats were hyper-excitable/hyperactive for the first 2 days of the study, and had dry red material around nose/mouth; clinical signs abated by day 5. Rat body wt did not change for the first 7 days, but increased normally thereafter. No gross necropsy findings were attributable to test article exposure.
Conclusions	
(study author)	No deaths occurred after exposure to 5.4g/m^3 for 4 hrs.
Data Quality	
Reliability	**1.** Reliable without restrictions
References	Gordon, T. 1983. LD_{50} Resin-Former Feedstock inhalation toxicity study in rats. Proj. #82-083. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co. Houston, TX
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Acute Toxicity

Test Substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Composition analysis, purity and stability referred to sponsor.
Method	
Method/guideline followed	None specified, comparable to standard study
Type (test type)	Acute- limit test
GLP	Yes
Year	1983
Species/Strain	Rabbit, New Zealand White
Sex	Males and females
No. of animals per sex per dose	5
Vehicle	none
Route of administration	dermal
Test Conditions	Rabbits (11-19 wks old, 2.04-3.10 kg) were individually housed in metal, screen-bottomed cages and received chow diet and water ad lib. Rooms were maintained at 72-85^{0}F with relative humidity of 30-80% and a 12-hour light/dark cycle. Before test article application, backs of the rabbits were shaved, and 4 parallel epidermal abrasions were made lengthwise on the shaved test site that penetrated the stratum corneum but not the dermal layer. Neat test article was applied over the site at 2000mg/kg and covered with a gauze patch and occlusive dressing that was taped in place, covered with a cotton sock and wrapped in an elastic bandage. Each animal was fitted with an Elizabethan collar to prevent ingestion. Test article remained on the skin for 24hrs after which wrappings were removed and residual test article wiped off. Observations for mortality, moribundity, clinical signs, and skin reactions were made immediately after removal of test article and then daily for 14 days, after which the rabbits were sacrificed and gross necropsies performed. Irritation was scored by the Draize method (scores 2-4).
Results	
LD_{50} with confidence limits.	Not reached at 2000mg/kg.
Remarks	No mortality occurred during the study, and body weight increased normally. Immediately after test article removal, rabbits showed slight to severe edema and slight to well-defined erythema (scores 1-4), which partially resolved over the 14-day observation period. Most of the rabbits had moderate to severe skin desquamation during the study, and by the end of the observation period, sloughing of dry patches revealed red skin, indicative of a persistent irritation. Gross necropsy did not reveal any adverse findings other than skin desquamation.
Conclusions (study author)	The median lethal dose is greater than 2000mg/kg. A persistent skin irritation was observed at the application site.
Data Quality	
Reliability	**1.** Reliable without restrictions
References	Rausina, G.A. 1983. Acute dermal toxicity study in albino rabbits, Resin-Former Feedstock. Proj. #82-075. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co. Houston, TX
Other	
Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Genetic Toxicity - in Vitro

Test Substance	
Test substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Amber colored, clear aromatic liquid with hydrocarbon odor. Composition analysis, purity and stability referred to sponsor.
Method	
Method/guideline followed	Standard method based on Hsie et al. (1981), O'Neill & Hsie (1979)
Type	In vitro mammalian cell forward mutation
System of testing	Chinese hamster ovary (CHO) cell culture
GLP	Yes
Year	1984
Species/Strain	CHO-K-1 heterozygous for hypoxanthine-guanine phosphoribosyl transferase (HGPRT+/-) from Oak Ridge National Laboratory, TN.
Metabolic activation	Yes
Species and cell type	Rat liver (S9) fraction purchased from Litton Bionetics, Kensington, MD
Quantity	1.0mg S9 fraction/ml treatment medium/flask
Induced or not induced	Aroclor 1254 induced (treatment not specified)
Concentrations tested	Cytotoxicity: 4, 8, 64, 128, 256, 512, 1024, 2048µg/ml ± S9; Mutagenicity: 64, 128, 256, 300µg/ml (350, 400µg/ml, cytotoxicity only) ±S9; all diluted in 10% Pluronic® polyol F68 (prepared in deionized water, mol. wt. 8350).
Statistical Methods	Frequency of mutant colonies per million clonable cells, corrected for absolute survival by viability plates, was calculated and comparisons of treated cultures with vehicle controls made on transformed data using a two-tailed t-test (Irr & Snee, 1979) using the MUTANT computer program (Snee et al., 1981). Criteria for positive results were significant ($p<0.05$) increase in mutant colonies (HGPRT+/-? HGPRT-/-) at any dose level and a dose related response. If only one criterion was met, results were considered equivocal.
Remarks for Test Conditions	Sufficient Resin-Former Feedstock was weighed separately for each dose level into 10ml volumetric flasks; 6.9ml of 10% F68 was added along with sufficient medium (Ham's F-12 without hypoxanthine) to achieve final 10ml volume for testing. All dosing preparations were vortexed just after addition of medium and just prior to addition of 20µl to each 3ml medium culture flask. All cultures were incubated at 37^0C in 5% CO_2 enriched, humidified atmosphere. Positive control mutagens were ethyl methanesulfonate (100µg/ml) for –S9 cultures, and benzo(a)pyrene (4µg/ml) for +S9 cultures. For cytotoxicity, each dose group was composed of 2 flasks, one –S9, one+S9, negative controls ± S9, seeded with $5x10^5$ cells on day 1. Cultures were exposed to test compound for 5 hours on day 2. On day 3, cells were trypsinized and counted with a Coulter Model ZB, then 200 cells were transferred into each of 3 60mm culture dishes. These viability plates were incubated until day 10, fixed in methanol and stained with Giemsa. Colonies were counted visually or with an Artek Model 981 colony counter. Absolute survival = total colony count ÷ number of cells seeded/flask. Relative survival = absolute survival in treated cultures ÷ vehicle control survival. Acceptable survival level is at least 10%. For mutagenicity, cells were seeded on day 1 into 6 flasks/dose group, 3-S9, 3+S9; on day 2 approximately 10^6 cells were exposed to Resin-former feedstock for 5 hours. Vehicle control had 12 flasks, 6-S9, 6+S9. On day 3, cultures with excessive cytotoxicity were discarded. From remaining cultures, 200 cells were seeded to each of 4 viability plates/dose level; incubated to day 10, fixed with methanol, stained with Giemsa, and colonies counted for survival. Expression cultures (10^5-10^6 cells/one dish/dose) were seeded on day 3; subcultured three times until day 10 when 200 cells were seeded on each of 4 viability plates/dose and $2x10^5$ cells seeded on each of 5 mutagenicity plates/dose with selective medium containing 10^{-5}M 6-thioguanine to allow expression of HGPRT mutation. Cultures were incubated undisturbed until day 17 when they were fixed and stained. For mutagenicity, a ratio of total colony counts in mutagenicity plates over absolute survival in viability plates was calculated for each treatment group. Frequency of mutant colonies/million clonable cells was calculated

	and statistical comparisons with negative control data were made.
Results Genotoxic effects	In the cytotoxicity test, Resin-Former Feedstock induced post treatment cell toxicity (greater than 10%) at dose levels of 128µg/ml and higher –S9 and at all dose levels+S9. Cloning of these cells showed toxicity compared to vehicle controls in -S9 cultures beginning at 8µg/ml (86%relative survival); survival decreased to 54.1% at 256µg/ml and 0% at higher doses with the exception of outlier value of 94.5% relative survival at 128µg/ml; in +S9 cultures, relative survival was equal or greater than vehicle controls up to 256µg/ml, above which dose no cells survived. In the mutagenicity test, post-treatment cell counts showed cytotoxicity at all levels -S9 (64-400µg/ml) and at 128µg/ml and higher +S9. Decreased cloning efficiency was evident at 256µg/ml and higher –S9, and at 350µg/ml and higher +S9. Cell viability after expression passage, at the time of mutant selection for dose levels 64-300µg/ml, was slightly decreased at 300µg/ml –S9 (90.3% relative survival) only. For all Resin-former feedstock exposed cultures ±S9, there were no significant dose-related responses nor any significant increase in mutation frequency compared to vehicle controls. Negative and positive controls responded appropriately: EMS –S9 induced 175.7 mutants/10^6cells; B(a)P +S9 induced 63.9mutants/10^6cells.
Conclusions (contractor)	Resin-Former Feedstock did not induce a mutagenic response with or without metabolic activation in CHO/HGPRT cells at any dose level. Resin-Former Feedstock does not cause gene point mutations in mammalian cells under the conditions of this assay.
Data Quality *Reliabilities*	**1**. Reliable without restrictions. Study conforms to standard design. GLPs have been followed
Reference	Papciak, R.J., and Goode, J.W. 1984. CHO/HGPRT test using Resin Former Feedstock Proj. #2065. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX Hsie, A.W. et al. 1981. Mut. Res. 86: 193-214 O'Neill, J.P. and Hsie, A.W. 1979. Banbury Report 2: 55-63 Irr, J.D. and Snee, R.D. 1979. Banbury Report 2: 263-275. Snee, R.D., Smith, R.L., and Irr, J.D. 1981. MUTANT. A computer program for the evaluation of short-term mutation test results. E.I. Dupont de Nemours Co.
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Genetic Toxicity - in Vitro

Test Substance	
Test substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Amber colored, clear aromatic liquid with hydrocarbon odor. Composition analysis, purity and stability referred to sponsor.
Method	
Method/guideline followed	Standard method based on Williams (1977) and Williams et al. (1977,1982)
Type	In vitro mammalian cell DNA repair assay
System of testing	Unscheduled DNA Synthesis (UDS) in primary hepatocyte cultures.
GLP	Yes
Year	1984
Species/Strain	Fischer 344 male rat (13-14 wks old) – 1 rat per test
Metabolic activation	No
Species and cell type	NA
Quantity	NA
Induced or not induced	NA
Concentrations tested	Range-finding: 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048µg/ml: UDS assay: 10, 20, 40 100µg/ml; all diluted in 10% Pluronic® polyol F68 (prepared in deionized water, mol. wt 8350, 80% hydrophilic)
Exposure period	18-20 hours
Statistical Methods	None employed. Criteria for positive response are incorporation of radioactive precursor (^{3}H-thymidine) in cells that are not normally synthesizing DNA, indicating repair of damage. A positive response is defined as a mean net nuclear grain count at any treatment level that exceeds concurrent negative control by at least 6 grains/nucleus; negative control value must not exceed 5 grains. A positive response need not be dose related.
Remarks for Test Conditions	Sufficient Resin-Former Feedstock was weighed separately for each dose level, 0.70ml of 10% F68 added per ml of final volume and sufficient medium (Williams Medium E with 10% fetal bovine serum and insulin) added to achieve final volume. Test preparations were stored at 37^{0}C until dosing and mixed just prior to addition at 30µl to each 3ml culture. The conc. of ^{3}H-thymidine (½ life 12.5 yrs.) used in these assays was 1mCi/ml. All cultures were incubated at 37^{0}C in 5% CO_2 enriched humidified atmosphere. For range-finding, primary hepatocytes derived from freshly perfused rat liver were seeded (approx. 1x10^5 cells/ml) into treatment vessels, exposed to test material for 19 hours (2 cultures/ dose level; 2 untreated cultures, and two vehicle F68 control cultures), then fixed in formalin and stained with trypan blue for viability determination. At least 50% viability needed for the assay. In the UDS assay, 1x10^5 cells/ml were seeded into coverslip cultures, exposed to ^{3}H-thymidine and test substance for 18-20 hours (3 cultures/dose level). Positive control was 2-acetyl aminofluorene (0.2µg/ml). Cells growing on coverslips were rinsed, fixed and glued to microscope slides on day 2. On day 3, slides were dipped in autoradiographic emulsion and stored in the dark at 2-8^{0}C. Autoradiographs were developed, stained and coverslipped on day 14. Number of grains overlying 50 randomly selected nuclei/slide were counted. The highest of 3 cytoplasmic grain counts/cell were subtracted to obtain net nuclear grain count. Avg. net nuclear grain count/slide (sum of net nuclear grain count ÷ 50) and mean net nuclear grain count (avg. net nuclear grain count/slide ÷3) were calculated. Slides with negative average net nuclear grain count were scored as zero.
Results	
Genotoxic effects	Resin-Former Feedstock induced toxicity in primary rat hepatocytes beginning at 32µg/ml (67.8% relative viability) following 19 hours exposure. Viability continued to decrease in a dose related manner (i.e. relative viabilities of 60.6% at 64, 34.7% at 128, and 29.1% at 256µg/ml) to the maximum dose of 2048µg/ml (2.5% relative viability). Resin-former feedstock did not induce UDS at any treatment level in this assay. Negative and positive controls responded appropriately (vehicle control mean net count of 0.80 and 2-acetyl aminofluorine mean net count of 122.61 net nuclear grains).

Conclusions (contractor)	Resin-Former Feedstock did not induce unscheduled DNA synthesis at any dose level administered to cultured rat hepatocytes. Resin-former feedstock does not cause DNA damage and repair in this assay.
Data Quality *Reliabilities*	**1**. Reliable without restrictions. Study conforms to standard design. GLPs have been followed.
Reference	Brecher, S., and Goode, J.W. 1984. Hepatocyte primary culture/DNA repair test of resin-former feedstock. Proj. #2067. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX Williams, G.M. 1977. Cancer Res. 37: 1845-1851 Williams et al. 1977. In Vitro 13: 809-817 Williams et al. 1982. Mut. Res. 97:359-370
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Genetic Toxicity - in Vitro

Test Substance	
Test substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Amber colored, clear aromatic liquid with hydrocarbon odor. Composition analysis, purity and stability referred to sponsor.
Method	
Method/guideline followed	Standard method based on Cortesi et al (1983), Dunkel et al (1981), Reznikoff et al (1973)
Type	In vitro cell transformation
System of testing	Mouse embryo cells
GLP	Yes
Year	1983
Species/Strain	BALB/3T3-A31-1-1 from T. Kakunaga, National Cancer Inst., 1982
Metabolic activation	No
Species and cell type	NA
Quantity	NA
Induced or not induced	NA
Concentrations tested	Cytotoxicity: 4, 8, 16, 32, 64, 128, 256, 512, 1024 and 2048µg/ml; Transformation: 16, 32, 64, 200µg/ml, all diluted in 10% Pluronic® polyol F68 (prepared in deionized water, mol. wt. 8350, 80% hydrophilic).
Exposure period	2 days
Statistical Methods	None employed. Criteria for positive response were a two-fold increase in type III foci at the highest dose over vehicle control (at least 2 type III foci if vehicle control had none) with or without a dose related response, or a two-fold increase at two or more consecutive doses. Test is equivocal if two-fold increase occurred at any one level other than the highest dose.
Remarks for Test Conditions	Sufficient Resin-Former Feedstock was weighed separately for each dose level; 0.7ml of 10% F68 added per ml of final volume and medium (Eagle's MEM with 10% heat-inactivated fetal calf serum + antibiotics) was added as required to achieve final volume for testing. Preparations were mixed and added at 50µl to each 5 ml culture. All cultures were incubated at 37^0C in 5% CO_2 enriched humidified atmosphere. For cytotoxicity, 2 flask cultures/dose group, 2 cultures for vehicle F68 or medium negative control were seeded with $1x10^4$ cells/culture in day 1, exposed on days 2-3, trypsinized and counted with a Coulter Model ZB on day 4 for at least 20% survival. For transformation, 15 flask cultures ($1x10^4$ cells/culture/dose group) and two colony formation flask cultures (100 cells/culture/dose group) were seeded on day 1, exposed on days 2-3 and culture medium changed on day 4. For transformation cultures, medium continued to be changed weekly to day 29. Positive control was 3-methylcholanthrene (1µg/ml). Colony formation cultures were fixed, stained, and counted visually on day 8 to determine cloning efficiency (avg. number colonies/flask ÷ 100 cells seeded). Transformation cultures were fixed and stained on day 29 for focus counting and evaluation. Transformation frequency = total type III foci ÷ total flasks/dose group.
Results	
Genotoxic effects	Resin-former feedstock induced toxicity in BALB/3T3 cells after two days exposure beginning at 32µg/ml (63% viability) with increasing toxicity to highest dose level, 2048µg/ml (7% viability); 80% cytotoxicity occurred between 128-256µg/ml. In the transformation assay, inhibition of cloning efficiency (C.E.) became evident at 64µg/ml (30.9% relative CE) and no colonies were detected at 200µg/ml. All treated cultures induced type III foci compared to negative controls. The 16µg (6 type III foci) and 200µg (8 type III foci) dose cultures had at least twice the type III foci seen in untreated medium controls (3 type III foci), and the 32µg and 64µg cultures had 4 and 5 type III foci, respectively. The positive control, 3- methylcholanthrene induced the expected response for transformation: 17 type III foci. Transformation frequencies were 0.43, 0.29, 0.38, and 0.62 for 16, 32, 64, and 200µg/ml groups, respectively, compared to 0.20 for medium control and 2.43 for positive control.

Conclusions (contractor)	Resin-Former Feedstock induced transformation at all dose levels in BALB/3T3 cells under conditions of this assay, with a significant 2.7 fold increase at the highest dose. Cytotoxicity and impairment of cloning efficiency were also observed.
Data Quality *Reliabilities*	**1.** Reliable without restriction. Study conforms to standard design. GLPs have been followed.
Reference	Brecher, S, and Goode, J.W. 1983. BALB/3t3 transformation test: Resin-Former Feedstock. Proj. #2068. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co, Houston, TX Cortesi, E. et al. 1983. Teratogenesis, Carcinogenesis, Mutagenesis 3: 101-110. Dunkel, V.A. et al. 1981. J. Nat'l Cancer Inst. 67: 1303-1315. Reznikoff, C.A. et al. 1973. Cancer Res. 33: 3239-3249.
Other *Last changed*	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel).

Genetic Toxicity - in Vivo

Test Substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Amber colored, clear organic liquid with hydrocarbon odor. Composition analysis, purity and stability referred to sponsor.
Remarks	
Method	
Method/guideline followed	Comparable to standard assay
Type	Mammalian bone marrow erythrocyte micronucleus
GLP	Yes
Year	1984
Species	Mouse
Strain	Crl:CD®–1 (ICR) BR Swiss
Sex	Male and female: 10M, 10F/group; 15M, 15 F in 1 group (11 wks old, 24-39g at start)
Route of administration	Oral gavage
Doses/concentration levels	0, 0.125, 0.25, 0.5g/kg in corn oil
Exposure period	1 dose/day for 2 days; 1 group- 1 dose, 1 day only
Statistical methods	Values from treated groups for daily mean body weights, group means and std. dev. for polychromatic erythrocytes (PCEs) with micronuclei (MN) , and group mean ratios of PCE to normochromatic erythrocytes (NORMs) were calculated and compared with vehicle control values by Student's t-test. Positive response was indicated by statistically significant ($p<0.05$) increases in micronucleated PCE at any dose level with a dose related response evident. Results were considered equivocal if only one of these criteria was met.
Remarks for Test Conditions.	Resin-Former Feedstock dosing solutions were prepared fresh for each day of dosing – 1.25 g was weighed into a 50 ml volumetric flask, corn oil was added to make up 50ml volume and contents blended by shaking. No range finding study was performed. Four groups of mice were given 0.0 (20ml/kg corn oil), 0.125-0.5g/kg test material in a single oral dose by gavage for 2 days. All mice were weighed on day 1 and on day of sacrifice. One half of each treated group and vehicle control (5M, 5F) was killed on day 3 and the remainder on day 4. One group (15M, 15F), given 0.5g/kg by gavage in a single dose for 1 day only, was killed on days 2, 3, 4 (5/sex/day). Positive control mice given cyclophosphamide (75 mg/kg) ip daily for 2 days were killed on day 3. Slides of femoral bone marrow smears were prepared, stained with May-Grunewald /Giemsa stain and examined microscopically. For each mouse, 1000 PCE and all associated mature erythrocytes (NORMs) were evaluated for presence of micronuclei. Data collected included group mean body weights for each day, total PCEs, total NORMs, PCEs with MN, and NORMs with MN.
Results	
Genotoxic effects NOAEL (NOEL) LOAEL (LOEL)	NOEL (genetic) = 0.5g/kg; NOAEL (systemic) = 0.25g/kg (levels assigned by reviewer). Mortality occurred in 1/10 males, 6/10 females in the 0.5g/kg for 2 days dose group, on or before day 2; in the 0.5g/kg for 1 day dose group, 2/15 males and 9/15 females died. Gross necropsy revealed yellow oily or red material in small intestines and/or stomach; 1 female had bilateral hydrometra. Perianal staining was observed. No significant wt loss occurred in surviving animals; 50% or more total treated animals survived to sacrifice, although mortality at 0.5g/kg single dose and 2 doses was 73% and 10% respectively among males, and 60% females in both dose regimens. Surviving animals treated with Resin-former feedstock did not show any significant change in frequency of micronucleus formation in polychromatic erythrocytes. In the 2 surviving females given 0.5g/kg test material for 2 days and sacrificed on day 4, a statistically significant decrease in PCE/NORM ratio was seen – 0.7 compared to 0.8 in solvent controls; all females in other dose groups and all males had PCE/NORM ratios comparable to controls. Positive and negative controls produced expected results; cyclophosphamide induced 4.5% and 3.30% micronucleated PCEs in male and female mice, respectively, sacrificed on day3.

Conclusions (study authors)	Oral treatment of Resin-Former Feedstock for 1-2 days at doses up to 0.5g/kg/day had no effect on frequency of micronucleated PCE in bone marrow. Resin-former feedstock did induce mortality at 0.5g/kg and some inhibition of PCE/NORM ratio in 2 high dose females treated for 2 days and killed on day 4. Under conditions of this study, Resin-Former Feedstock is not a clastogen.
Data Quality *Reliabilities*	**2.** Reliable with restrictions. Significant mortality at the highest dose.
References	Khan, S.H., and Goode, J.W. 1984. Micronucleus test in mouse bone marrow: Resin-Former Feedstock administered orally for 2 days. Proj. #2066. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX
Other *Last changed*	Revised 11/21/2001 (Prepared by a consultant to the Olefins Panel)

Repeated Dose Toxicity

Test Substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Composition analysis, purity and stability referred to sponsor
Remarks	
Method	
Method/guideline followed	None specified, comparable to standard study
Test type	Subacute
GLP	Yes
Year	1984
Species	Rat
Strain	Fischer 344
Route of administration	Dermal
Duration of test	14 days
Doses/concentration levels	0, 1.0, 2.0g/kg
Sex	5 Males, 5 Females/dosing group
Exposure period	6hr/day for 9 days (days 1-5, 8-11)
Frequency of treatment	Once/day
Control group and treatment	5 Males, 5 Females; corn oil (1g/kg)
Post exposure observation period	None
Statistical methods	Standard deviation, Bartlett's test, analysis of variance, Dunnett's test, Modified t-test, two-tailed Kolmogorov-Smirnov test.
Test Conditions	Rats (49 days old, 112-199g at initiation) were housed individually in suspended, stainless steel cages, with wire mesh fronts and bottoms, and equipped with automatic watering. Chow diet and water were provided ad lib. Room temperature and relative humidity were maintained at 75^0F and 51%, respectively, with a 12-hour light/dark cycle. Rats received a fixed volume of 2g/kg/day of dosing solution (including corn oil vehicle); test article doses were 0, 1.0, 2.0g/kg applied to the shaved area on the back, representing approx. 10% of body surface area. Test site was uncovered during exposure. After 6 hrs exposure, residual test article was wiped off. During exposure, rats wore Elizabethan collars to retard ingestion. Rats were observed for mortality and moribundity twice daily on dosing days and once daily on non-dosing days. Body wt was recorded at initiation, day 6 and at necropsy on day 12. Rats were observed for clinical signs once daily on dosing days. Dermal reactions were observed/scored immediately before dosing and after test article removal. Blood was taken from the orbital sinus before initiation and at sacrifice for measurement of total/differential white blood cells, red blood cells, platelets, hemoglobin, hematocrit, mean cell vol., mean corpuscular hemoglobin, mean corpuscular hemaglobin concentration, BUN, creatinine, alkaline phosphatase, Na, K, glucose, SGPT, protein, albumin and albumin/globulin ratio. All rats were sacrificed on day 12 and gross necropsies were performed. The following organs were weighed and processed for histopathology: liver, brain, heart, spleen, kidneys, testes. Skin sections, thymus, uterus, lungs, and ovaries were processed for histopathology.
Results	
NOAEL (NOEL)	NOEL systemic: Male not established (hydrocarbon nephropathy); Female 2.0g/kg. NOEL dermal: Male 1.0g/kg; Female 1.0g/kg (based on skin irritation).
LOAEL (LOEL)	LOEL systemic: Male 1.0g/kg (hydrocarbon nephropathy); Female not established. LOEL dermal: Male 2.0g/kg; Female 2.0g/kg (based on skin irritation). Values assigned by reviewer.
Remarks	No deaths occurred during the study and no moribund animals were found. There were no statistically or biologically significant changes in body wt. Mild to moderate erythema and edema were present in most rats at the 2.0g/kg dose (undiluted) but no rats were affected at 1.0g/kg (diluted 50:50 in corn oil). There were slight increases in total WBC counts and segmented neutrophils, in both males and females at 2.0g/kg. There were no biologically significant changes in organ wt at necropsy, but the skin of all high dose rats displayed variable degrees of visible pathological changes including erythema, and edema and

	desquamation. Histopathological examination of skin showed acanthosis, hyperkeratosis, and ballooning degeneration of keratinocytes with vesicle formation in all high dose rats. There was an excessive, statistically significant accumulation of hyaline droplets in the epithelial cytoplasm in kidneys from all male rats at the 1.0 and 2.0g/kg doses. There were no other test article related effects observed.
Conclusions (study authors)	The test article caused no overt signs of systemic toxicity at 2.0g/kg. Barely perceptible to well-defined erythema, edema, and desquamation were seen on the application sites of males and females. Kidneys of all test article treated male rats showed excessive levels of hyaline droplets.
Quality Reliabilities	**2.** Reliable with restrictions. In the absence of occlusion, some test material might have been lost through volatilization.
References	Rausina, G.A. 1984. Two-week repeated dose toxicity study in rats using Resin-former feedstock. Proj. # 82-085. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX
Other Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Repeated Dose Toxicity

Test Substance	Resin-Former Feedstock; 50-60% DCPD. 15-20% CPD/methyl CPD dimer, <2% BD/CPD dimer, 10-12% styrene, <2%xylene, <2%CPD. Composition analysis, purity and stability referred to sponsor.
Remarks	
Method	
Method/guideline followed	None specified
Test type	Subacute
GLP	Yes
Year	1983
Species	Rat
Strain	Fischer 344
Route of administration	Whole body Inhalation
Duration of test	12 days
Doses/concentration levels	0, 0.6, 2.5g/m^3 (actual)
Sex	5 Males, 5 Females/exposure group
Exposure period	9 days
Frequency of treatment	6hr/day for 9 days (days 1-5, 8-11)
Control group and treatment	5 Males, 5 Females; filtered air
Post exposure observation period	None
Statistical methods	Bartlett's test for organ wt followed by Dunnett's test, or modified t-test and analysis of variance. Microscopic findings were evaluated using Kolmogorov-Smirnov analysis.
Test Conditions	Rats (14 wks old, 152-297g) were housed individually in stainless steel, screen bottomed cages in a room maintained at 76.1^{0}F and relative humidity 42%, with a 12-hour light/dark cycle. Animals were provided with water and chow ad lib, except during exposure. Three groups of 10 rats were exposed to aerosolized test article for 6 hr/day for 9 days. Test article was aerosolized with a ball jet nebulizer. Chambers were sampled with a gas-tight syringe and samples were injected directly into a gas chromatograph. Chamber concentrations were determined by GC; comparing sample peak area with that of standards. High volatility of the test article prevented collection of gravimetric samples, so particle size was determined during exposure by lazer velocity measurement (MMAD= 4.8 at 0.6g/m^3 and 6.9 at 2.5g/m^3; 60-65% of particles <10µm). Rats were observed twice daily on dosing days and once daily on weekends for mortality, and once daily after exposure on dosing days for clinical signs. Body wt was taken prior to exposure on day 1 and 5, and prior to sacrifice on day 12. Blood was collected via orbital sinus on days 5 and 12 for measurement of total/differential white blood cells, red blood cells, platelets, hemoglobin, hematocrit, mean cell vol., mean corpuscular hemoglobin, mean corpuscular hemoglobin conc., blood urea nitrogen, creatinine, alkaline phosphatase, Na, K, glucose, SGPT, protein, albumin, and albumin/globulin ratio. Rats were sacrificed on day 15 and gross necropsies were performed. Organs were weighed and tissues collected for histological examination of tissues from high dose and control rats, and kidneys from low dose males and females. The following organs were weighed: liver, brain, heart, spleen, lungs, kidneys, and testes. The following organs/tissues were prepared for histopathology: brain, heart, lungs, liver, spleen, kidneys, testes, nasal turbinates, thymus, and ovaries; tissues from control and 2.5g/m^3 groups were examined microscopically.
Results	
NOAEL (NOEL)	NOEL was not established in this study.
LOAEL (LOEL)	LOEL: Male 0.6g/m^3 (based on walking with arched back, exclusive of hydrocarbon nephropathy which occurred at 0.6 and 2.5g/m^3); Female 0.6g/m^3 (based on walking with arched back, muscular tension, twitching) (All values assigned by reviewer.)
Remarks	There were no deaths during the study. Statistically non-significant decrease in body wt was seen in both sexes in all groups, including controls (males 1-6%, females 1-7%); it was suggested that nauseating test article vapors were present in the animal holding room, indicating some exposure to controls. The control group showed no remarkable clinical findings during the study and there was no indication of test article deposition on the body

	surface. At 0.6g/m^3, by the second week, several rats walked with arched back and had body rigidity and twitching. At 2.5g/m^3, arched back and rigidity were seen throughout the study, twitching was common by day 4 and lasted until termination; 8/10 rats convulsed at least once. The duration and severity of convulsions varied, but incidence increased by the second wk; males and females were equally affected. Frequency and severity of neurological symptoms were related to level and duration of exposure. There were infrequent occurrences of hyper-excitability, pupil dilation, ocular darkening, and swaying. There were no biologically significant differences in clinical pathology values between treated and untreated rats, but low glucose values were seen at 2.5g/m^3 in both sexes. Liver wt was significantly increased in females at 2.5g/m^3 (18%). Male rats showed microscopic and dose responsive changes in tubular epithelium of kidneys with excessive accumulation of hyaline droplets. No brain abnormalities were observed.
Conclusions (study authors)	Resin-Former Feedstock exposure caused no mortality. Important clinical signs were seen, including convulsions, muscular tension, arched back, ocular and respiratory discharges that were dose related. Gross and microscopic tissue changes were seen including increased liver wt in females at 2.5g/m^3, and excessive hyaline droplets in proximal convoluted tubular epithelium of 0.6 and 2.5g/m^3 exposed males.
Quality Reliabilities	**1.** Reliable without restrictions
References	Gordon, T. 1983. Nine-day repeated dose inhalation toxicity study in rats, Resin-former feedstock. Proj. # 2025. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX
Other Last changed	Revised 11/21/2001 (Prepared by a contractor to the Olefins Panel)

Robust Summary: Resin Oils and Cyclodiene Dimer Concentrates Category

Fish Acute Toxicity

Test Substance	Resin-Former Feedstock (50-60% dicyclopentadiene, 15-20% methylcyclopentadiene/cyclopentadiene dimer, <2% butadiene dimer, 10-12% styrene, <2% xylene, <2% cyclopentadiene)
Method	
Method/guideline followed	None specified, comparable to standard method
Year (guideline)	Unknown
Type (test type)	Acute toxicity, static renewal
GLP	Yes
Year (study performed)	1983
Species	Rainbow trout (*Salmo gairdneri* now refered to as Oncorhynchus mykiss) and Bluegill sunfish (*Lepomis macrochirus*)
Analytical Monitoring	Yes
Exposure Period	96 hours ± 1hr
Statistical Methods	24, 48, and 96-hour LL50 values were calculated using Probit analysis (SAS system). Chi square performed on each dose response curve to ensure non-heterogeneity and goodness of fit.
Test Conditions Note: Concentration prep., vessel type, volume, replication, water quality parameters, environmental conditions, supplier of organisms, age, size, weight, loading	Treatment solutions of resin-former feedstock were prepared 1 day before test initiation to achieve maximum saturated test material loadings. Test substance was added to 25L charcoal-filtered, municipal water in each of the 100 mg/l, test vessels and stirred vigorously throughout the day. Test concentrations were assigned by a random numbers table (2 vessels/dose group). 10 fish/species/vessel were added. Starting at one end of the bioassay table, 2 fish were placed in each vessel in consecutive order to the opposite end of the table, then proceeding in reverse direction, 2 more fish were added per vessel until all vessels had 10 fish. Sexes were not determined; at least 120 fish of each species were tested. A preliminary limit test of 100 mg/l resulted in 100% mortality in both species. Dose levels for this assay were 3.2, 5.6, 10, 14, 18, 32 mg/L nominal concentrations to rainbow trout and 10, 14, 18, 32, 56, 100 mg/L to bluegill sunfish. A glass lid was placed on top of each vessel to minimize volatile losses. Solutions were not aerated. Dissolved O_2 concentrations were within acceptable ranges (8.6-10.2mg/l for rainbow trout, 7.4-9.1 for bluegill sunfish). Experimental conditions were: water temp. 10.6-11.6^{0}C and pH 6.8-7.8 for rainbow trout; water temp. 18.2-19.4^{0}C and pH 7.5-8.0 for bluegill sunfish; photoperiod of 12-hr light/dark cycle for both species. Animals were not fed during the 96-hour exposure period. Positive control compound was benzene at concentrations of 5.6, 7.5, 10, 14, 18 mg/l, prepared as an aqueous solution immediately prior to administration to rainbow trout only. There was an insufficient supply of bluegill sunfish for positive control exposure. Mortality and pharmacotoxic signs were recorded daily at intervals of 1, 6, 24,48, 72, and 96 hours, as number fish affected/total fish exposed. Water temp., dissolved O_2 conc., and pH were measured daily for each bioassay vessel in old and freshly prepared test solutions. Total alkalinity (39-41 mg/l as $CaCO_3$), total hardness (97-106 mg/l as $CaCO_3$), and specific conductance (336-421 µmhos/cm) were measured in each vessel during the first 6 hours, and at 48 and 96 hours. A water sample was taken at mid depth from each test solution daily for a total of 8 samples: 1 before test initiation when introduced into vessels, 2 for each of next 3 days (1 from old solution, 1 from fresh solution), and 1 at test termination, to analyze for actual conc. of test material by gas chromatography/FID. Rainbow trout: 36-48 mm length, 0.56-1.86 g supplied from Castalia/Millsite Farms, Castalia, OH, USA. Bluegill sunfish: 30-50 mm length, 0.57-2.99 g supplied from Sea

Results Units/Value: Note: Deviations from protocol or guideline, analytical method, biological observations, control survival	Plantations, Inc., Salem MA, USA. LL50 values (with 95% feducial limits) are based on nominal concentrations: Rainbow Trout (mg/L) — Bluegill Sunfish (mg/L) 24-hr LL50: 14.34 (12.5-16.27) — 21.95 (19.71-25.80) 48-hr LL50: 10.92 (not determined) — 17.91 (16.28-20.69) 96-hr LL50: 10.60 (3.60-63.88) — 13.54 (12.28-14.66) For rainbow trout, % mortality at 96 hours was 5, 10, 25, 95, 100% at nominal concentrations of 3.2, 5.6, 10, 18, 32 mg/l respectively, with pharmacotoxic signs of surfacing, rapid respiration, dark discoloration, bloated abdomens, gyratory swimming, and lying on bottom of vessels. For bluegill sunfish, % mortality at 96 hrs was 0, 75, 85, 100, 100, 100% at nominal concentrations of 10, 14,18, 32, 56, 100 mg/l, respectively, with pharmacotoxic signs of surfacing, rapid respiration, swimming on side, excreting mucus, and lying on bottom of vessel. The benzene 96-hour LC50 in rainbow trout = 7.64 mg/l. Results of chemical analysis of water samples were inconsistent and highly variable, and analyses were discontinued. Test material was observed on water surface and adhering to sides of vessels in treatment solutions.
Conclusions (study author)	
Data Quality *Reliabilities*	**(2)** Reliable with restrictions Analytical characterization of test material in aqueous test solution was inaccurate and unreliable. Quality Assurance final report statement had not been signed by a reviewer. Test material was observed on water surface and adhering to sides of vessels in treatment solutions.
Reference	Glenn, L.S. and Rausina, G.A. 1983. 96-Hour Aquatic Toxicity Study in Rainbow Trout and Bluegill Sunfish with Resin-Former Feedstock. Project #2021. Gulf Life Sciences Center, Pittsburgh, PA for Gulf Oil Chemicals Co., Houston, TX, USA.
Source	American Chemistry Council, Olefins Panel